Printed on Thin Paper for Foreign Circulation.
"THE ENGINEER," JANUARY 29, 1932.

With METALLURGICAL SUPPLEMENT.

The Engineer.

Established 1856.

Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 28, ESSEX ST., STRAND, LONDON, W.C. 2.

VOL. CLIII.—No. 3968] LONDON: FRIDAY EVENING, JANUARY 29, 1932 [PRICE { WITH SUPPLEMENT } ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES.

Corporation of Nottingham.

WATER DEPARTMENT.
REINFORCED CONCRETE WATER TOWER.

The Water Committee invite TENDERS from experienced Reinforced Concrete Contractors only for the CONSTRUCTION of a WATER TOWER at Stanton-on-the-Wolds, Notts.

A copy of the general conditions, specification, quantities, and form of Tender may be obtained from Mr. F. W. Davies, Engineer and General Manager, Water Offices, Castle Boulevard, Nottingham.

Applications must be accompanied by a cheque for Three Guineas, which will be refunded on receipt of a bona fide Tender and return of all documents.

Sealed Tenders, endorsed "Tender for Water Tower," must be delivered to me at my office not later than 15th February, 1932.

By Order,
W. J. BOARD,
Town Clerk.

Guildhall, Nottingham.
25th January, 1932. 8062

County Borough of Preston.

TENDERS are INVITED for the SUPPLY during the twelve months ending March 31st, 1933, of 4500 YARDS of 30in. Diameter STEEL WATER PIPES with Bituminous Lining and Exterior Sheathing.

Specification and form of Tender (returnable 11th February, 1932) may be obtained from the office of the Water Engineer, Titheburn-street, Preston, and applications should be accompanied by a remittance of One Guinea, which will be returned upon receipt of a bona fide Tender for the work.

ALFRED HOWARTH,
Town Clerk.

Town Hall, Preston.
16th January, 1932. 8032

County Borough of Wolverhampton.

BARNHURST SEWAGE PURIFICATION WORKS.
CONTRACT NO. 10.
TO MAKERS OF PUMPS AND ELECTRIC MOTORS.

The Corporation is prepared to receive TENDERS for the SUPPLY of a CENTRIFUGAL PUMP driven by an ELECTRIC MOTOR for pumping sewage which has received tank treatment.

The pump will be required to deliver about 2000 gallons of sewage per minute against a total head of about 25ft.

Tenderers will be required to submit prices for the manufacture, delivery and installation of the required plant, piping, switchgear and other details.

On and after the 27th January, 1932, specifications, bills of quantities and forms of Tender may be obtained from the Engineers, Messrs. Dodd and Watson, MM. Inst. C.E., Wellington House, Bennetts Hill, Birmingham, on payment of a deposit of £1, which will be returned only on the receipt of a bona fide Tender and the return of all documents.

A drawing showing the various details of the pumping station and the pipe lines will accompany the specification.

Sealed Tenders, addressed "J. Brock Allon, Esq., Town Clerk Wolverhampton," and endorsed "Tender for Contract No. 10," should be delivered at this office not later than Noon on Wednesday, February 17th, 1932.

The Corporation does not bind itself to accept the lowest or any Tender.

J. BROCK ALLON,
Town Clerk.

Town Hall, Wolverhampton.
22nd January, 1932. 8068

Farnham Urban District Council Waterworks.

CONTRACT No. 10.
TO BRITISH MANUFACTURERS OF SELF-PRIMING PUMPING PLANT.

The Farnham Urban District Council is prepared to receive TENDERS for the SUPPLY and ERECTION of TWO HORIZONTAL ELECTRICALLY DRIVEN SELF-PRIMING BOOSTING PUMPS, to be installed at the site of the Council's Victoria Reservoir.

The works included in the contract consist of Pumps, Electric Motors, Automatic Starting Apparatus, Air Pressure Tank, Compressor, &c., with all accessories, all in accordance with the drawing, general conditions and specification prepared by the Engineers, Messrs. John Taylor and Sons, Caxton House, Westminster, S.W. 1.

The general conditions, specification and a copy of the drawing may be obtained by the manufacturer from the offices of the Engineers upon payment of £5 (cheque only), which will be returned upon receipt of a bona fide Tender.

Tenders in sealed envelopes, endorsed "Tender for Pumping Plant," must be delivered at my office at Farnham before Noon on Thursday, the 18th day of February, 1932.

The Council does not bind itself to accept the lowest or any Tender.

By Order,
(Signed) A. A. MINNS,
Clerk.

Council Offices,
Farnham, Surrey. 8075

Metropolitan Water Board.

TENDERS FOR THE SUPPLY OF SLUICE VALVES, HYDRANTS, &c., AND PHOTO PRINTS.

The Metropolitan Water Board invite TENDERS for the SUPPLY of the undermentioned STORES and SERVICES for the periods of six and twelve months, commencing 1st April, 1932:—

TENDER No. 21.—SLUICE VALVES and HYDRANTS, &c.

TENDER No. 27.—PHOTO PRINTS, &c.

Tenders must be submitted on the official forms, which may be obtained on and after Monday, 1st February, 1932, from the Chief Engineer, by personal application at the offices of the Board (Room 156) or upon forwarding a stamped addressed sack envelope. Applicants should refer to the number of the Tender for which forms are required. Samples of the paper required in connection with Tender No. 27 can be seen at the offices of the Board (Room 201).

Tenders, enclosed in sealed envelopes, addressed to The Clerk of the Board, and endorsed in the manner indicated in the form of Tender, must be delivered at the offices of the Board (Room 122) not later than 11 a.m. on Monday, 22nd February, 1932.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1.
25th January, 1932. 8072

The Engineer

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PUBLIC NOTICES.

Llandrindod Wells Urban District Council.

WATERWORKS PUMPING PLANT.

TENDERS are INVITED from experienced British Manufacturers for the SUPPLY and ERECTION in duplicate of PUMPING PLANT, comprising Turbine Pumps direct coupled to D.C. Electric Motors, to be erected at Llanfawr. The pumps are required to lift 24,000 gallons per hour through an 8in. rising main, 1020 yards long, the nett lift being 150ft. Automatic control to be provided for each set with all accessories to make the installation complete. Tenders for alternative plants, as set out in the specification, will be considered.

General specifications and form of Tender may be obtained from the Engineers, Messrs. Piddian and Deeley, 13, Church-street, Stourbridge, on payment of a deposit of Two Guineas, on and after Monday, February 1st, to be refunded on receipt of a bona fide Tender.

Sealed Tenders, endorsed "Tender for Pumping Plant," must be delivered to the undersigned not later than Noon on Monday, February 22nd, 1932. The Council does not bind itself to accept the lowest or any Tender.

D. C. DAVIES,
Clerk to the Council.

Town Hall, Llandrindod Wells.
25th January, 1932. 8063

The Bengal and North-Western Railway Company, Limited.

The Directors are prepared to receive TENDERS for the SUPPLY of :—

520 BUFFERS,

as per specification to be seen at the Company's offices.

Tenders, addressed to the undersigned and envelope marked "Tender for Buffers," with name of firm tendering, to be lodged not later than Noon on the 23rd day of February, 1932.

For each specification a fee of 10s. will be charged, which cannot, under any circumstances, be returned.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
W. R. IZAT,
Managing Director.

227, Gresham House,
Old Broad-street, London, E.C. 2.
January 26th, 1932. 8080

PUBLIC NOTICES.

Fulham Borough Council.

GENERATING STATION EXTENSIONS.

The Fulham Borough Council is prepared to receive TENDERS for the following ENGINEERING WORKS in connection with the extension of the Council's Generating Station in Townmead-road, Fulham, viz.:—

SECTION "A."—GENERATING PLANT.—The Manufacture, Delivery, Erection and Maintenance of Two 75,000-kVA. Turbo-alternators, with Exciters, Feed-water Heaters, &c.

SECTION "C."—STEAM RAISING PLANT.—The Manufacture, Delivery, Erection and Maintenance of Six Water-tube Boilers, each for an evaporation of 260,000 lb. per hour, with Retort Stokers, Economisers, &c.

The specifications, drawings, &c., may be inspected at the office of Messrs. Preece, Cardew and Rider, 8, Queen Anne's-gate, Westminster, S.W. 1, to whom all technical inquiries should be addressed.

Copies of the specification (in duplicate), together with copies of the drawings, general conditions and form of Tender, may be obtained on written application to the Borough Treasurer at the Town Hall, Fulham, London, S.W. 6, accompanied by a deposit of £10 for each section of the works. This deposit will be returnable only if the tenderer shall have sent in a bona fide Tender within the prescribed time and shall not have withdrawn the same. Additional copies of the specifications may also be obtained upon payment to the Borough Treasurer of £1 for each copy, which will not be returnable.

Tenders must be submitted in the printed envelopes provided and all Tenders must be sealed and appropriately endorsed and delivered to the undersigned not later than 10 a.m. on Monday, the 7th day of March, 1932.

The Council will not consider any Tender for either section of the works which does not cover the whole of the works specified for that section. The Council will also not necessarily accept the lowest or any Tender for either section, or compensate for the preparation of unsuccessful Tenders.

WILFRED TOWNEND,
Town Clerk.

Town Hall, Fulham, London, S.W. 6.
20th February, 1932. 8061

BOOKS WANTED

WANTED TO PURCHASE, MINUTES OF THE PROCEEDINGS of the INSTITUTION of CIVIL ENGINEERS, Volumes 224 to 231.—Offers to B. T. BATSFORD, Ltd., Technical Booksellers, 15, North Audley-street, London, W. 1. 8093 P

PUBLIC NOTICES.

The Chinese Government Purchasing Commission.

The Commission is prepared to receive TENDERS from British manufacturers for 85 lb. per yard RAILS and FASTENINGS.

Tender forms, &c., can be obtained on and after Monday, February 1st, at the offices of the Consulting Engineers,

Messrs. SANDBERG,
40, Grosvenor-gardens,
London, S.W. 1.

A fee of £1 5s., which is not returnable, will be charged for each set of documents. 8096

The Engineers' Register of the Junior Institution of Engineers,

39, VICTORIA-STREET, S.W. 1, licensed annually by the London County Council, contains the names and specialised experience of many Members, both Junior and Senior Men, who are available for service in administrative and technical capacities in all branches of engineering.

Employers seeking such men for service, either in Great Britain or abroad, are invited to address their inquiries to the SECRETARY. P1920

NOTICE TO FOREMEN.

The National Foremen's Association

is an Association of Foremen formed to represent them on all questions affecting their supervisory interests.

For full particulars apply GENERAL SECRETARY, 95, Belgrave-road, Westminster, S.W. 1. 7968

SITUATIONS OPEN.

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

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For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge and co-operation is asked for.

WANTED, for Engineering Offices and Works abroad, ENGINEER, age about 30 (unmarried), having served apprenticeship in British Railway Company's Locomotive or Carriage Workshops. Public School man preferred with good technical education. Must have good presence and be capable of interviewing Railway Officials. Good salary will be paid to suitable candidate.—Address, giving full particulars of age, education, experience, &c., 8076, The Engineer Office. 8076 A

WANTED, YOUNG MAN to Assist in Foundry Manager's Office. Must have practical experience in Motor Cylinder Moulding, Core-making, Cupola Practice, Drawings, &c. Able to Estimate Weights, Quote for Castings and attend Technical Correspondence.

State age, experience, salary required.
Address, 8094, The Engineer Office. 8094 A

BIRMINGHAM ELECTRIC FURNACES, Ltd., Erdington, REQUIRE IMMEDIATELY YOUNG TECHNICAL SALES ENGINEER; good address essential. State experience and salary required. 8092 A

ENGINEER WANTED for Oilfield in Burma. Willing to train as Diesel Dredge Operator and/or Oilfield Engineer. Good general practical mechanical training and with good oil engine experience. Drawing-office experience a recommendation. Single man, not over 25. First agreement, 3 years. Salary, excluding allowances, but including Provident Fund, Rs. 3900, Rs. 4550, Rs. 5200 per annum. Passage paid, medical expenses and quarters free.—Reply, giving age, full particulars of experience and copies of testimonials, to Z.R.370, Deacon's Advertising Agency, Fenchurch-avenue, E.C. 3. 8084 A

INDUSTRIAL ENGINEER WANTED by Large Manufacturing Organisation. First-class general and all-round technical education essential; also experience in Manufacturing Operations, including Combustion Processes, Conveying, Gearing and Heavy Electrical Plant.

Age about 35.

Address, stating age, experience, and salary required, P1977, The Engineer Office. P1977 A

REPRESENTATIVE ENGINEERS REQUIRED on commission basis by Superheater and Pipework Manufacturers. Connection among steam users essential. State full particulars and Territory worked in confidence.—Address, 8078, The Engineer Office. 8078 A

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The Engineer

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This Directory, which is published annually in the interests of advertisers in THE ENGINEER, may be obtained free of charge on application to the Publisher.

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DRAUGHTSMAN. — Thoroughly Competent DRAUGHTSMAN WANTED for works about 25 miles south of London. Must have had considerable experience in designing of high-class machinery. State concise details of experience and salary required. —Address, 8046, The Engineer Office. 8046 A

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A.M.I. STRUCT. E. DESIRES POSITION in Structural Engineering Co., with control of drawing-office or designing and estimating dept.; 17½ years' London experience.—Address, in confidence, P1982, The Engineer Office. P1982 B

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A Seven-Day Journal

Trade Exhibition on a Liner.

PROVIDED that sufficient support is forthcoming, the Anchor-Donaldson Line, of Glasgow, is offering to Scottish manufacturers an opportunity, free of charge, of exhibiting their products on board one of the company's liners at Montreal for one week early in May. The scheme which has been formulated provides for an exhibition on the "Letitia," the 13,465 gross tons 17-knot liner built by the Fairfield Shipbuilding and Engineering Company, Ltd., of Govan, in 1924. It is understood that Scottish manufacturers generally have given the proposal their support, and that considerable space in the ship has already been allocated. It is felt that while many of the British ships entering the St. Lawrence are clearly recognised as outstanding examples of Clyde shipbuilding craftsmanship, the products of Scottish industries are not always as well known in the Dominion of Canada as they might be. The "Letitia" berths at Montreal, within a few minutes' walk of the centre of the city, and there is no doubt that the exhibition if held, will be visited by a large number of people. It will, it is intended, be opened by a prominent member of the Canadian Government and will be made known throughout Canada beforehand. Canada is, it is pointed out, already familiar with such means of displaying her manufactures, and Australian products have been shown in Canadian ports on an exhibition ship, while early this month a Canadian ship left Halifax for a two months' cruise in the West Indies, having on board exhibits of goods arranged by eighty Canadian manufacturers. It is hoped that the Anchor-Donaldson proposal will meet with the success it undoubtedly deserves.

Sir Arthur Duckham and Iron and Steel.

SPEAKING at Darlington last Friday, Sir Arthur Duckham, the President-elect of the Federation of British Industries, put forward some interesting facts in support of his contention that immediate action was necessary to check the flow of imports into this country of products which we could ourselves manufacture. Since 1929 there had, he said, been a decline of 50 per cent. in the production of iron and steel, and the number of men employed had fallen by 60,000, or over 30 per cent. Exports of iron and steel had fallen by 2,500,000 tons since 1929, and for the first time in the history of the industry imports had exceeded exports by over 1,000,000 tons. Sir Arthur Duckham declared that the iron and steel industry was in danger of virtual extinction, and pointed out that should it fail our great engineering and building industries would be at the mercy of foreign manufacturers and any price-fixing agreement they might arrive at. He then proceeded to estimate what the effect of the imposition of protective duties would be. Assuming that there was an increase of 2,000,000 tons in home production, then directly and indirectly employment would be found for 80,000 men; 6,000,000 tons more coal would have to be raised, and 5,000,000 tons of additional ore and 750,000 tons more limestone would be required. There would be at least 12,000,000 tons more traffic for the railways, and the engineering and allied industries would be stimulated by demand for new plant. There would be a saving on the Unemployment Insurance Fund of over £4,000,000. It was reasonable to assume that, following upon a real increase in the amount of production, there would be a corresponding decrease in costs.

The First Clyde Launch in 1932.

ON Monday last, January 25th, the high-speed turbine-driven cargo and livestock carrying steamer "Slieve More" was launched from the Leven Yard of William Denny Bros., Ltd., the naming ceremony being performed by Lady Hartley, the wife of Sir Harold Hartley, Vice-President of the London, Midland and Scottish Railway Company. At the luncheon which followed the ceremony Mr. Maurice Denny said that the launch was noteworthy as being the first on the Clyde for 1932. He also announced that his firm had the distinction of being the first on the Clyde to book an order this year. That order, he said, was for the construction of a new cross-Channel steamer for the Newhaven-Dieppe service of the Southern Railway Company. The L.M.S. steamer "Slieve More," Mr. Denny continued, will be an improved "Slieve Bloom," having an overall length of 310ft., a beam of 44ft. 6in., and a depth of 15ft. 6in. She is to be propelled by a twin-screw arrangement of Parsons' single-reduction geared turbines, steam being raised in two Babcock and Wilcox coal-fired, water-tube boilers designed for a pressure of 225 lb. per square inch and working on the closed stokehold system. Mr. Denny also referred to other work recently entrusted to his firm by the L.M.S. Company, namely, the repair and reconditioning of the Heysham-Belfast steamer the "Duke of Lancaster," which took fire in port and sank alongside the dock. Salvage work was proceeding vigorously, and it was hoped that the ship would be back at Dumbarton very soon, when she would be reconditioned as rapidly as possible. Sir Harold Hartley, referring to railway cross-Channel services, said that the L.M.S. steamers carried to Holyhead from Dublin yearly some 80,000 tons of produce, valued at £1,500,000, and also 450,000 head of livestock, valued at about £5,000,000, in addition to about 90,000 tons of manufactured goods to the Irish Free State. The passenger service was maintained by three fast ships, the "Scotia," "Hibernia," and "Cambria," which, with the exception of the "Mauretania" and "Majestic" and the "Bremen" and "Europa," were, Sir Harold stated, the fastest passenger ships in the world. They were built by Messrs. Denny in 1921, and the company had recently arranged for them to be reconditioned at Dumbarton, so that they would be made in every way equal to their fine speed performance. In 1931 the L.M.S. marine fleet made 4791 Irish Channel crossings and carried 750,000 passengers, 1,750,000 parcels, one-third of a million tons of merchandise, and 590,000 head of livestock.

Empire Broadcasting.

AT a meeting of the Royal Empire Society, held on Monday, January 25th, Mr. Noel Ashbridge, the Chief Engineer of the B.B.C., dealt with the Empire Broadcasting Station which is to be opened at Daventry at the end of this year. Sufficient data had been collected, he explained, to indicate that there was an abundant desire on the part of overseas listeners generally, and in particular those in the Colonies, for a service from Great Britain. Empire broadcasting would be made possible by the use of short waves. The Chelmsford station, G.5.SW, had been working on experimental lines for several years, but the station had been unable to give a satisfactory service for the whole of the territory which would normally be covered because it had been worked on one wave length. The question of planning an Empire broadcasting station had been explored along the lines of making use of directional effects, and for that purpose the Empire would be divided into five zones. Starting on that basis, the technical equipment would be designed to give the best possible reception facilities for each of those zones, particular stress being laid on good reception between the local times of 6 p.m. and midnight, although it was hoped with the aid of omni-directional aerials to provide satisfactory reception at other hours of the day. To allow advantage to be taken of experience as the service developed, the aerial arrangements would admit of modification. The contract for the Empire Station at Daventry had been placed and the work had already been begun; but on the completion of the station some months of careful testing would be necessary before it would be possible to start routine working. It would be necessary to gain experience from the tests before a definite schedule could be completed, but the station should be ready to radiate its initial programme before the end of the year.

Sir Andrew Duncan's Visit to Canada.

A FEW days ago Sir Andrew Duncan sailed on the Canadian Pacific steamer the "Duchess of York" for Halifax. In 1925 he was Chairman of the Royal Commission which was set up to investigate and report on the coal industry in Nova Scotia, and the Commission, which in addition to Sir Andrew consisted of two Canadians, Major Hume Cronyn and the Rev. Hugh P. MacPherson, assisted by mining and accountancy experts, reported in record time. The Dominion Government accepted the recommendations of the Commission and gave them full force, with the result that up to recently the industry has prospered. Apparently one of the principal troubles was strife within the industry itself. Further trouble has now developed, and, knowing how intimately acquainted the members of the original Commission are with the problems involved, the Dominion Government decided to endeavour to get the same Commission to carry out further investigations, and accordingly made representations to the Home Government.

The New Cunarder.

IN a circular issued by the directors of the Cunard Steam Ship Company, Ltd., to the shareholders on Wednesday last, January 27th, the board amplifies its statement of December 10th and reviews the position as it is six weeks after its decision to stop work on "No. 534," now under construction at John Brown's Clydebank Yard. The directors re-affirm their conviction that she is the right ship to build as well in the interests of the company as of the nation. They further state that they have never lost faith in the company's ability to operate her, either with existing ships or later with a future sister, in such a manner as will enable her to pay her way, and if opportunity is afforded they are quite willing to lay before the Government the facts upon which the company's views are based. The statement in the circular goes on to discuss the company's method of financing new tonnage and the financial achievements of the company in the past, recalling the building of the "Mauretania" and "Lusitania" by means of a loan from the Government, repayable with interest in instalments over a period of twenty years. If the Government could see its way to renew similar financial facilities in favour of the Cunard Company's present replacement programme, it would undoubtedly be of material assistance, the statement proceeds, in enabling the work on the ship to proceed at an earlier date than may otherwise be found possible. It is further pointed out that the basis on which the new liner is to be built is purely economic, and that her construction is at this moment suspended depends not on factors inherent in the North Atlantic trade, not on factors domestic to the company, but on international factors, which are hampering the ordinary financial machinery of commerce.

The Sunken Submarine M 2.

LITTLE hope, we fear, remains that any of the officers and crew—some seventy men—on board H.M. submarine "M 2" still survive. As we write no news has been received from the submarine since she sank shortly after 10 o'clock on Tuesday morning while exercising alone off Chesil Beach in the West Bay, Portland Bill. The search for the missing submarine has continued unavailingly, although every possible means to discover her whereabouts and to salve her have been employed. The mine-sweeper "Tedworth," which is equipped with the latest appliances for deep diving, has left Devonport for Portland to assist in the search. The "M 2" was begun under the War Emergency Programme, and was completed by Vickers in 1920. She has an overall length of 303ft., a breadth of 24ft. 6in., and a depth of 15ft. 9in. She is of the Admiralty double-hulled pattern, and her machinery comprises a twin-screw arrangement of twelve-cylinder, four-stroke, Vickers airless-injection motors, each of 1200 B.H.P., giving her a speed of about 15·5 knots on the surface and 9·8 knots when submerged. She originally carried a 12in. Mark XI. gun, but this was removed and its place taken by a water-tight hangar, in which a small Parnall "Pixie" seaplane with folding wings was housed, the machine being launched by a catapult. The submarine had the reputation of being a handy boat to dive and easy to control. As yet it is not possible to indicate the cause of her sinking, but, according to witnesses who saw her submerge, something unusual would seem to have taken place.

Railway and Road Transport.

ON Tuesday, January 26th, the general managers of the four British railway companies had an interview with the Minister of Transport in response to his invitation that they should express their views on the Final Report of the Royal Commission on Transport. They took the opportunity of placing before the Minister certain representations regarding the relationship between rail and road transport, assessing the losses caused by road competition. The railway companies estimate that they have lost net revenue owing to road competition at the rate of £16,000,000 per annum. Of this total it is estimated that £10,000,000 is attributable to passenger traffic and £6,000,000 to goods traffic. This estimate, we understand, does not bring in 1931, but is based on a comparison of the year 1930 with 1923. In their endeavour to place their industry on a level footing for competitive purposes with the road transport industry, the companies found that the most serious handicap lay in the inequality of treatment given to the rail and road respectively. The statement dealt with the position in some detail, and recommendations with a view to amending the present position were put forward. In referring further to the statement, Sir Ralph Wedgwood has pointed out that it was desired to secure a full measure of equality between rail and road transport; that there should be a proper apportionment of cost between users of the road; and a measure of regulation applied to the carriage of goods by road corresponding to the regulations which applied to the carriage of goods by railways. If genuine equality was established, he believed that the railways could carry on successfully.

Waterloo Bridge.

AT a meeting of the London County Council last Tuesday, Sir Percy Simmons, Chairman of the Improvements Committee, announced that in the opinion of the members of that Committee the only satisfactory solution to the problem presented by Waterloo Bridge was to erect a new bridge to carry six lines of traffic in its place. It will be remembered that towards the end of July last year the Government announced that it was not prepared to provide 75 per cent. of the cost of the proposed Charing Cross Bridge, and that, in consequence, it became necessary to consider the rebuilding of Waterloo Bridge. The suggestion was made, alternatively to that of dismantling the present bridge and building a new one, that the present bridge should be repaired and a new one built at the Temple, the idea being that one-way traffic should be worked on each. Sir Percy Simmons stated that traffic considerations—more particularly since there is not to be a Charing Cross bridge—required that Waterloo Bridge shall be rebuilt, and, on economical grounds, it would be difficult to justify the expenditure of reconditioning the existing bridge when, for not more—and probably less—than an additional £250,000 a six-line bridge could be erected. The other scheme, involving a new bridge at the Temple, would be very considerably more expensive. The Ministry of Transport, should the Council decide to rebuild Waterloo Bridge, will, we understand, bear 60 per cent. of the cost out of the Road Fund.

The Justification of Organised Engineering Inspection.

By W. P. DIGBY.

No. I.

THE real cause and justification for the employment of an inspector directly by the purchaser—or, what amounts to the same thing, indirectly by the purchaser's consulting engineer or buying agent—is that of securing the maximum efficiency in the expenditure of capital. In a perfect world there would be no need for either outside engineering inspection by those whom some brand as Ishmaelites, nor for internal testing by the works testing department, which is so often a veritable Cinderella. In a perfect world there would be no imperfect steel or iron castings, furnace products would never vary in composition, heat treatment would be uniform. The many machines used in the control of iron and steel production would be superfluous—the Buckton, Brinell, Izod and Wohler machines and high-power microscopes become museum curiosities. The Cinderellas in electrical works would no longer clamour for oscillographs, potentiometers, or for testing transformers of greater ranges, and standard instruments of super-accuracy.

In short, a world without imperfection would no longer need to burn incense to any such tribal deities as progress or competition, works foremen would be as obsolete as the pterodactyl, and the world would have already obtained that Nirvana to which the Buddhist yogis aspire.

We have, however, in the stress of competition, under the stimulus of progress in all the sciences, to recognise that the elimination of common-place, widely recognised irregularities is only one phase of inspection, that new materials, new conditions and the attainment of further technical improvement, all introduce new and novel irregularities which cannot always be foreseen. The recognition of this fact justifies alike the works testing department and the consulting engineer. The latter is a super-specialist who cannot be ubiquitous and must delegate certain work to other specialists; that is to say, to skilled engineers who will inspect and test the work at all stages. There is no need to-day to justify either the position of the consulting engineer or that of those engineers employed by large firms who deal with the buying of plant and equipment. They are recognised as an essential part of modern business. There are, however, reasons to justify the employment of the inspector, as his salary forms part of the capital expenditure which the purchaser incurs. The writer contends that the employment of an inspector of adequate skill and experience can save waste of capital to an amount that is very rarely recognised. The primary capital saving is immediately apparent—efficient inspection is calculated to secure efficient plant adequate for its duties, and—as consulting engineers so often phrase it—"complete in all respects for immediate and beneficial use by the purchaser." In short, efficient technical inspection is generally accepted as a form of technical insurance. It is, however, less widely recognised that the efficient inspector can play a very valuable part by keeping such close touch with the work that progress to a predetermined schedule will ensure delivery by the contract date in its due sequence, so that the loss of interest on idle capital may be kept to a minimum. We will elaborate this side of the work later. It is better first to set out certain questions, and then to answer them. Thus, the obvious preliminary questions are:

(1) What is meant by inspection?
(2) How is it effected?
(3) What are the essential qualifications of an efficient inspector?
(4) What are the relations generally prevailing between: (*a*) The inspector and his principals? (*b*) the inspector and the works officials?
(5) Is inspection justified in all cases?

(1) By inspector the writer means a skilled engineer experienced in the manufacture of the plant or machinery with which he is concerned, conversant with the properties of the materials used, including defects in material and results of methods of treatment, who is delegated by the consulting engineer or other representative of the purchaser to ensure compliance with the terms of the contract. He must watch the quality of materials and grade of workmanship, take routine tests of materials used, and apply either special or customary tests to the finished article as the works facilities permit.

While he has powers of summary rejection of anything at variance with the specification, it is not always desirable that he should have powers to accept anything complying with the specification. Unless specially designated, it is his duty to report fully and to recommend acceptance. He should, however, be empowered to inform the contractors that he is recommending acceptance and to authorise dismantling, painting and packing.

(2) Inspection can be carried out either by resident or by travelling inspectors. Resident inspectors can be classed as either local or special. The local resident inspector usually works for more than one principal—he resides in the locality and can become, in course of time, a specialist in one or more sections of the work produced in his district. It is only rarely that he is as efficient as the special resident inspector sent to a district for three or six months to deal with one contract, giving every day to one stage or other of that contract. A special resident inspector is selected by his principals on account of special knowledge of the class of work concerned not merely as characteristic of the locality, but as characteristic of other works in other localities or abroad.

A suitable special resident inspector costs more per day than the ordinary local resident—he should however, be more efficient. In general, the special resident inspector should not reside too long in one district. This is desirable from all points of view. All human beings are subject to the contagion of staleness and slackness in the repetition of dull routine. This is no new phenomena—nearly 1700 years ago a philosopher whose life was divided between the palace and the camp remarked that "the continual sight of the same things and the uniformity make the spectacle tedious."

A good type of special resident inspector welcomes change of scene of occupation. He is subject to less risk of boredom. His responsibility is direct. He never farms out work. He is unlikely to be subject to that curse of life of the local resident inspector, alternations of over-work and next to no work. The principals employing a special resident inspector have no reason to anticipate that he may succumb to the solicitation to leave his stamp with a friendly foreman and later collect mill sheets and test records. While the special resident is, as we have said, less cheap to the purchaser than the local resident, there is good reason to believe that the latter has the greater income. There is less reason to believe that the man who serves two or more masters has an all-round efficency superior to that of the man serving only one master. But it is only contracts of a special class that require the whole time, day in day out, of a special resident inspector. The alternative is then to employ the travelling inspector. The travelling inspector falls into three categories. There is the travelling inspector whose duties are confined to one class of work. A period of travelling inspection is a welcome change for the special resident inspector, sandwiched in between periods of residence in a selected spot. Next, we have travelling inspectors whose duties may cover several classes of work. Given reasonable knowledge of each class, efficient work is done by them so long as they are able to give adequate time to their work. It is, however, a matter of derision in the works if a principal has sent a first-class boiler inspector to test a high-tension transformer, and the inspector begins by asking where the rotor is.

The travelling inspector again costs the purchaser more than the special resident inspector—not that the remuneration is necessarily higher, but the travelling expenses increase the cost.

We now come to the organising and supervising inspector. Upon him should rest the general supervision of all resident and travelling inspectors. His preliminary visits and discussions with the works officials when test details are settled and time schedules agreed as regards the chief contractors, his occasional visits to assist a special resident inspector, and his presence at important tests, are only part of his utility. It is upon his foresight in the control and co-ordination of work on a number of different contracts for the same scheme, that the loss of interest on capital which is idle is kept to a minimum. Further, he can act as the eyes of the consulting engineer or the buyer, and after less than two decades of varied inspection work it is not inconceivable that a good and keen type may have acquired an ability to assess the value of works' promises, and a memory of works' performances, good and bad, which are of value to his principals. Temporarily, indeed, he would become fitted to take over a buying department. During five years he would increase his skill in hard bargaining and synchronously lose his intimacy of knowledge of works and works' processes. After the end of five years at his office table his special initial qualifications would have faded out; so rapidly do processes and *personnel* change. Like Antaeus, who needed contact with Mother Earth to regain his faculties, the inspector turned buyer would need again to come in contact with the sand of the foundry, the swarf of the machine shop, and the gadgets of the test room to re-qualify himself.

(3) The essential qualifications of an efficient inspector may be briefly summarised as the ability to gain and retain the confidence of his principals and the respect and confidence of the works. Technically, he must know his job, but that does not mean mere text-book knowledge. He must never forget that there are tricks of the trade, from the racing of the weight along the arm of a Buckton tensile testing machine to the use of instruments whose margin of error, while beyond B.S.I. limits, will never err on his principal's side. He must know how spongy castings are dealt with in order that they may pass hydraulic pressure tests. He must know the instruments and not be misled into using wrong constants in reporting electrical pressure tests. He must know when to disregard both favourable and unfavourable tests.

(4) (*a*) First, the inspector must, by his work, satisfy his principals that their confidence is justified. He should be free to discuss his difficulties and apprehensions with them. True, the principals will be the court of appeal in the event of difficulties with the works—then the inspector's presentation of the works' point of view must be scrupulously fair. He may even have to be the apologist of the works and support by his evidence an appeal against the terms of a specification it is his duty to enforce.

Chiefly, he suffers from insufficient personal contact with his principals. That, however, is a fashionable modern source of inefficiency in many fields.

(*b*) Of the relations between the works officials and the inspector, the cynical epigram of twenty years ago that the works' attitude could be summarised as "hostility disguised as hospitality" by no means tells the whole story. The relations to-day range from contempt to respect. Contempt can be acquired in many ways. Ignorance accounts for much. Laziness amounting to dishonesty accounts for more. Domineering manners have at times raised antipathies to the end that some men are more hated for rejecting with good justification twenty pounds worth of material than others for rejecting material of fifty times greater value. A man technically very good may be anything but a success until—if he can—he has learned patience and tact.

Above all, lips must be sealed. Not a word must be said in A's works of anything seen in B's works, unless B's descriptions of his machines or processes or materials have been partially broadcasted in the Press. Even then lips must be guarded so that information which has not been broadcasted is never alluded to. On the other hand, the inspector is entitled in his talks with officials at A's works to use all common knowledge together with any special knowledge which does not involve disclosure of B's, C's or D's successes or difficulties, so long as the use of that special knowledge helps his clients. If it has no relation to the work in hand, it is better to discuss the composition of a cricket team or the latest nine-days' Press hysteria. If he has methods of testing which are not the secret of another firm which it is expedient to use, he is entitled to seek to have these adopted, even if unspecified, being morally certain that if those tests are valuable his principals will specify them in the future.

Uniform strictness is essential. To this should be added punctuality. It should go without saying that if he fixes a day for a test that date must be observed. To press for prompt delivery and then to keep works waiting is glaringly unfair.

Those with whom he deals will soon classify him as competent or incompetent, as fair or unfair, as reasonable or arbitrary. For every decision there must be a reason, and a sustainable reason, no matter whether that decision is an obvious one backed by the definite terms of the contract or is backed only by some all-embracing but nebulous phrase, capable of more than one interpretation. In many cases it is not necessary to use the word "reject;" the suggestion that material shall be withdrawn or replaced suffices. If the cause of a breakdown is obscure, it is better to stay for the inquest and discuss the deductions with the management than rush for a train. The presence at such investigations of an inspector who has the confidence of the works is never resented. It is, indeed, a frequent occurrence for the social relations to be those of a circuit mess, except that "shop" is the predominant subject of conversation. Time and again, the man who is known to observe the code of secrecy is the recipient of confidences from designers and works managers, and has his attention called to, and his views sought on, many phenomena which are never chronicled in papers read at the institutions. This is no Utopian ideal—from one end of the United Kingdom to another, directors, managers, and foremen will be found who will say that they always welcome certain inspectors. They are not always equally frank about their contempt.

As already stated, there are only certain classes of work which call for special resident inspectors, and their work has to be day-in and day-out. It should begin when the first deliveries of material enter the works, not when the first consignment, say, of pipes is ready for pressure test, or when the first consignment of rails is stacked on the cold rail bed ready for examination.

The travelling and supervising inspector's first visit should be at the commencement of the work, particularly in the case of contracts with a penalty clause for late delivery. The primary object of his first visit should be to agree on the progress schedule for all operations involved in completing the contract by the due date. Interim visits to observe progress and workmanship are of value. First, they indicate whether or not specified materials are being used, or, let us say, whether patching or welding is taking place. It is useless, for example, to specify that the insulating material shall be of certain materials applied in a certain way, and to hold the inspector responsible for an ultimate failure due to disregard of this clause, unless he has seen the work actually in process of construction. It is quite as important, but not as much a matter of convention, to see the turnings when a crank shaft is in the lathe, as it is to pull tensile test pieces from the original forging. Secondly, interim visits are the means best calculated to secure delivery at the contract dates. Even the best works

tend to become case-hardened and impenitent over late deliveries. Usually they can hope to blame their sub-contractors M or N for being late. It is part of the object of efficient control by the inspector to see that M and N are not late, and if they are to induce a friendly management to give special priority to the work so that delivery is not prejudiced. The rights and therefore the implied duties of the inspector are generally clearly defined in most specifications. A common clause empowers the inspector "to have access at all times to the works of contractors and sub-contractors to inspect, examine, and test the materials and workmanship there."

(To be continued.)

Heat Absorption in Water-cooled Furnaces.

IN the design of modern steam generation plants a stage has now been reached in which the permissible tolerances in performance are reduced to such a low degree that precise and reliable prediction of performance becomes much more necessary than has generally been the case hitherto, and is rapidly becoming imperative. The technical knowledge of combustion, of radiation, of resistance to flow of gases, has so far increased as to permit of quite accurate predetermination of performance to be made, provided all the necessary factors and conditions are known. The calculations to be made and the analytical work to be done to secure this knowledge is of so extensive a character that it would be impracticable to apply such methods if every factor which influenced the result was a variable.

If it be granted that prediction of performance can be attained by the application of our present high standard of technical knowledge, instead of by the older methods of "cut and try," then it becomes clear that to make the new method practicable the number of variables should be reduced to a minimum.

A very extensive step in this direction can be made by strict standardisation of design of a selected form of steam generator and arranging for a limited number of sizes to be so standardised. Thus, if eight sizes are selected and standardised, then all those factors dependent on relative areas of exposed surfaces can be established by calculation, can be proved by actual performance, and can remain unaltered in all future applications of these standard sizes. There will be, of necessity, a number of variables dependent on the requirements of the purchaser and the local conditions. Thus the quality of fuel to be used may vary over a wide range, working steam pressures and temperatures may be different, and there may be variation in air and feed-water temperatures. Provided the variables are known and are limited to a relatively small number, it is possible to prepare curves and charts of performance covering a reasonably wide range of the variables and secure by interpolation a sufficiently accurate forecast of performance under any conditions within that range.

In addition to the desirability of being able to predetermine performance under a known set of conditions, it is, of course, also necessary to provide for variation in performance to meet changes in demand and progressive changes of an internal character, such as are produced by a reduced degree of cleanliness of the heat-absorbing surfaces. Such variation can be met by the controls which are incorporated in the design of the plant. Thus, provision is made to vary the amount of superheat imparted to the steam by the operation of by-pass allowing more or less gas to flow over the superheating surface, while all variation in capacity can be controlled in the customary manner.

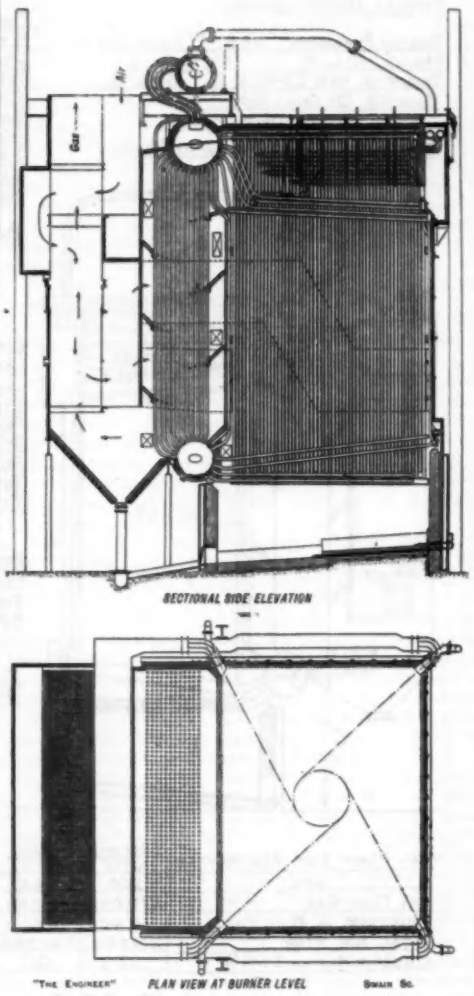
The course of procedure outlined in the foregoing has been adopted in the design, the manufacture and application of the combustion steam generator.

After a long period devoted to main principles of design with full consideration of manufacturing methods and essential requirements of operation and maintenance, a series of sizes was established and every detail in each size of the series was standardised. In course of the development, a considerable amount of data was obtainable as a result of practical performance and experimental operation. Finally, it was possible, by co-operation with those having the most extensive technical knowledge of the subject, to compile a record of the laws, formulas and fundamentals, and from this build up a series of tables and charts which would be available to those responsible for predetermining the performance of the combustion steam generator. The work thus referred to has been collected in a volume containing over two hundred pages of calculations, charts and tables, and it has been possible to make comparisons between predicted and actual performance, plotting the performance curves on the predicted curves and demonstrating the extraordinary accuracy and reliability of the prediction.

The method employed in the preparation of these tables and charts was explained at some length in a paper presented before the American Society of Mechanical Engineers by Prof. W. L. DeBaufre in December, 1930, from which we take the following passages.

"With the development of steam generators in which the furnace walls are almost entirely replaced by water-cooled surfaces, it became desirable to have a relation which would more definitely proportion the total heat absorbed by the unit between the heating surface exposed to radiation in the furnace and the heating surface in the boiler tube banks. About that time appeared the timely papers upon the subject by Broido and Wohlenberg, with Orrok's discussions thereon. Broido and Orrok gave empirical relations for calculating the ratio of the heat absorbed by radiation to the heat liberated in the furnace, which relations were assumed to apply to all types of furnaces and conditions of operation; but the actual ratio might differ by 20 per cent. from the calculated value. The paper by Wohlenberg showed how complicated the subject becomes when it is attempted to take account of all factors involved in the problem.

The idea was therefore conceived of applying a comparatively simple relation involving a factor which measures the effectiveness of the water-cooled surface and varies with the furnace design and the character of the fuel burned. This relation will be derived and applied to certain experimental data



"INTERNATIONAL COMBUSTION" BOILER

from pulverised-coal-fired furnaces. The method of applying the results to design problems will then be explained.

The above-mentioned relation is based on the furnace heat balance that the heat R radiated from the burning fuel and products of combustion plus the sensible heat P in the products leaving the furnace must equal the net heat B produced by burning the fuel plus the sensible heat A in the preheated air supplied for combustion; that is:

$$R+P=B+A.$$

These heat quantities may be total hourly rates for the furnace in question, or may be based on 1 square foot of water-cooled surface in the furnace, or on 1 lb. of fuel fired.

Due to unburnt combustible in the ashes and flue dust, the heat B actually liberated in the furnace is less than the calorimeter heating value of the fuel, which is accordingly reduced by 14,600 times the fraction of a pound of unburnt carbon per pound of fuel fired. A further reduction is made equal to the heat required to evaporate the moisture in the fuel and that formed from the hydrogen burned. The latent heat of this water vapour is taken as approximately 1050 B.Th.U. per pound at room temperature; that is:

$$B=H-14{,}600\times C-1050\times M,$$

where H = gross calorimeter heating value of the fuel fired, B.Th.U. per pound;

C = pound unburnt carbon per pound of fuel fired, and

M = pound moisture in fuel and formed from hydrogen per pound of fuel fired.

The sensible heat A in the preheated air is calculated from the amount of air supplied for combustion, the portion of it which is preheated, and the temperature to which it is preheated. The quantity of air supplied per pound of fuel fired may be calculated from the analysis of the products of combustion leaving the furnace, the composition of the fuel fired, and the loss of combustible in the ashes and flue dust.

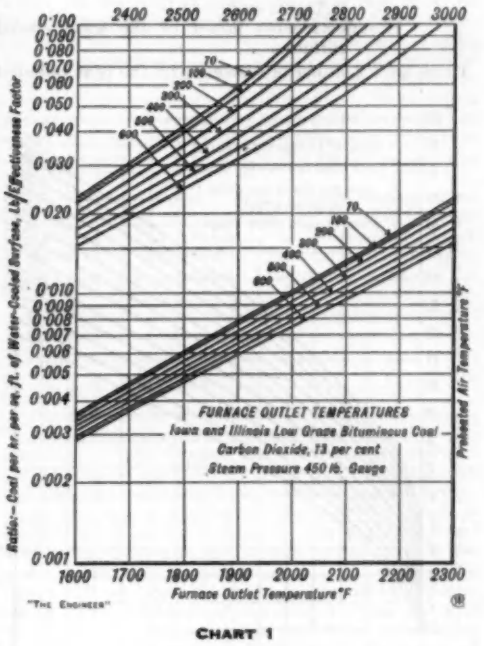

Ratio—Coal per hr. per sq. ft. of Water-Cooled Surface, Lb./Effectiveness Factor
Preheated Air Temperature °F
FURNACE OUTLET TEMPERATURES
Iowa and Illinois Low Grade Bituminous Coal
Carbon Dioxide, 13 per cent
Steam Pressure 450 lb. Gauge
Furnace Outlet Temperature °F
"THE ENGINEER"

CHART 1

The sum of A and B is the net heat available for radiation in the furnace and for heating the products of combustion to the furnace-outlet temperature. The sensible heat S in the products of combustion may be calculated for the composition and temperature of the products leaving the furnace. The heat R radiated is then found by difference.

Now, the more effective the water-cooled surfaces in absorbing heat within the furnace the larger must be R and the lower must be the temperature of the products leaving the furnace. Hence, the ratio of R to some function of the furnace-outlet temperature is an 'effectiveness factor' for the water-cooled

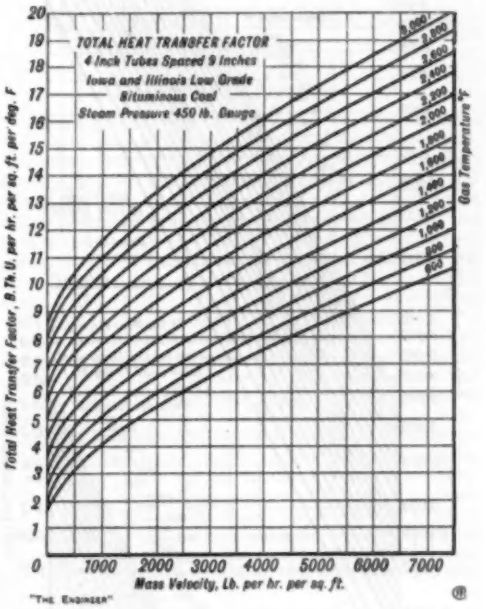

TOTAL HEAT TRANSFER FACTOR
4 Inch Tubes Spaced 9 Inches
Iowa and Illinois Low Grade Bituminous Coal
Steam Pressure 450 lb. Gauge
Total Heat Transfer Factor, B.Th.U. per hr. per sq. ft. per deg. F
Gas Temperature °F
Mass Velocity, Lb. per hr. per sq. ft.
"THE ENGINEER"

CHART 2

surfaces within the furnace. As the effectiveness of these surfaces must vary with their arrangement and condition, the effectiveness factor will show by its variations the effect of such changes rather than be a universal constant which will apply under all conditions.

The temperature function which has been chosen as a basis for calculating the effectiveness factor of the water-cooled surfaces is the fourth power of the absolute temperature of the products of combustion leaving the furnace minus the fourth power of the absolute temperature of the water evaporating within the water-cooled surfaces. The effectiveness factor E may be employed to calculate the heat R

radiated per pound of fuel fired by means of the relation :

$$R=\frac{E}{F}\left[\left(\frac{T_G}{1000}\right)^4-\left(\frac{T_S}{1000}\right)^4\right],$$

where T_G = absolute temperature of the products of combustion leaving the furnace, deg. Fah.

T_S = absolute temperature of the water evaporating into steam within the water-cooled surfaces, deg. Fah.

F = fuel fired per hour per square foot of water-cooled surface exposed to radiation, pound ;

R = heat radiated per pound of fuel fired in B.Th.U., and

E = effectiveness factor of the water-cooled surfaces.

There are a number of reasons why the heat radiated

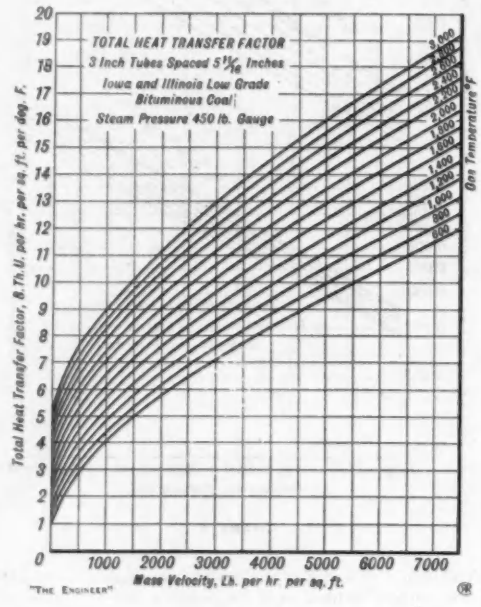

TOTAL HEAT TRANSFER FACTOR
3 Inch Tubes Spaced 5 1/16 Inches
Iowa and Illinois Low Grade Bituminous Coal
Steam Pressure 450 lb. Gauge
Total Heat Transfer Factor, B.Th.U. per hr. per sq. ft. per deg. F.
Gas Temperature °F
Mass Velocity, Lb. per hr. per sq. ft.
"THE ENGINEER"

CHART 3

by the burning fuel and products of combustion to the water-cooled surfaces should not be proportional to the difference of the fourth powers of the furnace-outlet absolute temperature and the absolute steam temperature. Thus :

The temperature of the burning fuel and products of combustion within the furnace is not uniform,

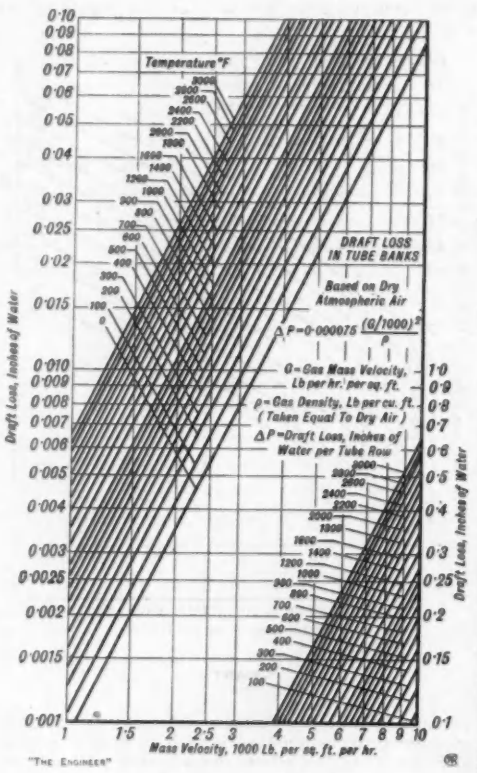

Temperature °F
DRAFT LOSS IN TUBE BANKS
Based on Dry Atmospheric Air
ΔP=0·000075 (G/1000)² / ρ
G=Gas Mass Velocity, Lb per hr. per sq. ft.
ρ=Gas Density, Lb per cu. ft. (Taken Equal To Dry Air)
ΔP=Draft Loss, Inches of Water per Tube Row
Draft Loss, Inches of Water
Mass Velocity, 1000 Lb. per sq. ft. per hr.
"THE ENGINEER"

CHART 4

but varies from a maximum at the place of most intense combustion to a minimum generally at the furnace outlet.

The water-cooled surfaces absorbing radiant heat are at a higher temperature than the water evaporating into steam within these surfaces.

Some heat may pass by convection and conduction rather than by radiation.

Radiation from non-luminous gases does not follow the fourth-power law, and radiation from burning fuel may not follow this law.

The flames may not entirely fill the furnace volume.

Clouds of cool, unburnt fuel may intervene between the hot flames and part of the water-cooled surface.

Combustion may not be complete within the furnace, but continue into and through the boiler-tube banks.

All of these discrepancies affect the effectiveness factor when the above relation is applied to determine its value for any set of experimental conditions. All of them, however, depend mainly if not entirely upon the characteristics of the fuel, the arrangement and condition of the furnace, and the capacity at which it is operated. Hence, the effectiveness factor determined by the above relation should apply to similar fuels, similar furnace arrangements and equal capacities.

The effectiveness factor will also vary with the way in which the water-cooled surface exposed to radiation is measured. While the projected area is the simplest way of measuring such surfaces, actual exposed areas have been employed, partly because it has been customary to measure these surfaces in this way, but also because the actual areas were considered to give a better comparative measure of the heat absorbed ; for example, by the first rows of boiler tubes and by furnace-wall tubes. Two-thirds of the surface of the first row of boiler tubes and one-third of the surface of the second row have been taken as exposed to radiation. Two-thirds of the surface of the 'screen tubes,' which are usually widely spaced, has been taken as exposed to radiation. When a wall is made up of plain tubes closely spaced, the exposed area has been taken as one-half of the tube surface. If widely spaced in front of a refractory wall, two-thirds of the surface has been taken. For fin tubes, the actual area of tube and fins on the furnace side has been taken as exposed to radiation."

Professor DeBaufre was able, as a result of his investigation, to conclude that the effectiveness factor is not affected by the percentage of CO_2 in the gases, nor by the temperature of preheated air.

From the numerous charts referred to above, four have been selected as examples and will serve to indicate the form in which data is available for the purpose of predetermining actual performance.

Actual performance with steam generators operating in such widely separated territories as England, America, Germany, France, Spain, Belgium and Sweden has, in each case, shown a remarkable agreement with that which could be predicted by reference to the charts.

Since heat transmission is dependent upon the composition of the gases, it is necessary to know the character of the coal to be used, and in order to avoid making calculations for each individual fuel, the fuels commonly utilised have been so classified that variations within each class are for practical purposes unimportant. Charts have been prepared for each class.

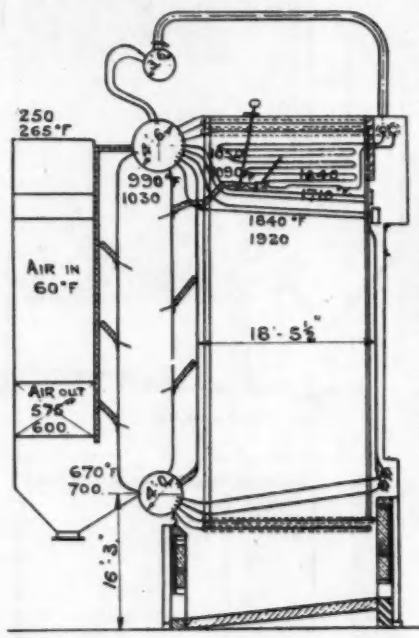
Charts 1, 2 and 3 are for temperature determination for one of the classes of fuel referred to. They are based on an effectiveness factor of 1500 and are subject, in addition, to a correction factor derived from a consideration of other known influences.

By the aid of Chart 1, the furnace outlet temperature can be determined for 450 lb. steam pressure, and 13 per cent. CO_2, and allows for a variation in

STEAM GENERATOR DATA SHEET

TYPICAL INSTALLATION.

DESIGN PRESSURE 385 #/SQ IN G.A
MILLS R L II. N° / UNIT 2
BURNERS PER CORNER 2 SIZE 8
BURNER DESIGN TYPE "T"
UNIT FIRED
FINENESS 70% THRO' 200 MESH



FURNACE VOL	10566	CU FT.
R.H.S.	3539	SQ FT
CONVECTION SURFACE	16.156	SQ FT
TOTAL SURFACE	19.695	SQ FT
FURNACE TUBES	4"	O.D.
BOILER TUBES REAR BANK 3" OTHERS 4"		O.D.
SCREEN TUBES	4½	O.D.
S.H. OUTLET FLANGE 2 N°	10"	BORE
SAT PIPE SIZE 2 N°	9"	"
SUPERHEATER SURFACE	5100	SQ FT
ELEMENTS ON	80	CLS.
AIR HEATER SURFACE	58.000	SQ FT
ELEMENT SPACE ⅜ AIR ⅛ GAS		
4'·6" WIDE AND	24'·0"	LONG

PERFORMANCE

	NORMAL	MAX
EVAPORATION		
LBS/HR ACTUAL	175.000	200.000
LBS/HR. F & A. 212°F.	214.000.	244.000
STEAM PRESS #/SQ IN GA	362.	373.
PRESS AT S.H. OUTLET	325	325
STEAM TEMPS S.H. OUTLET	780	800
SUPERHEAT °F	351	371
TOTAL HEAT	1.183	1.182
FEED TEMP °F	258	270.

B.T.U LIBERATED

PER CU. FT. FURN. VOL	23.100	26.700
PER SQ. FT. R.H.S.	69.000	79.800
FUEL REQ'D #/HR	25.700	29.700
EFFICIENCY GUARANTEE	86·05	86·05

FUEL MIXTURE 4 PTS BITUMINOUS, 1 PT SEMI ANTHRACITE

ANALYSIS

F.C.	47·92	C.	55·68
ASH	17·61	H	3·26
VOL	23·73	S	0·95
B.T.U.	11.600 GROSS	N.	1·06
MOISTURE	10·74	O	6·70
		H_2O	10·74
		ASH	17·61

GAS TEMP ENT AIR HEATER	NORMAL	MAX
" " LVG. " "	250	265
DRY FLUE GAS #/HR	270.000	312.000
MOISTURE IN FLUE GAS	14.400	16.600
TOTAL AIR #/HR	214000	242.000
CO_2 (AIR HEATER EXIT) %	13·2.	13·2.

OPERATING RANGE
CONTINUOUS 58000 - 200.000 LBS EVAPORATION

	STATIC PRESSURE.	R.P.M.	VOL CU. FT.
2 N° F.D. FAN.	6·15	1440	31.600
2 N° I.D. FAN.	6·95	960	53.000

"THE ENGINEER" SWAIN SC

SAMPLE DATA SHEET

From the charts given as an example is 4, being one of those from which the resistance to the passage of the gases may be determined.

A sample data sheet worked out from the particulars given by the charts is reproduced above, and the type of boiler covered is represented by a drawing on page 119.

THE Bolton Electricity Committee has decided to purchase apparatus for controlling the frequency of the supply at the Back-o'th'-Bank generating station. Mr. Annett, electrical engineer, explains that this is the prelude to a scheme for providing current for special purposes. For instance, firms can have a system for running electric clocks from the mains at a cost of 1s. 3d. per year. It is believed that this will become an almost universal system of time-keeping, especially in large industrial centres such as those in Lancashire.

The Training of Engine-room Artificers.

THE transfer of the "Fisgard" artificers' training establishment from the four hulks in Portsmouth Harbour to a converted building ashore at Chatham is a very important milestone in the history of naval engineering, for it is not only another indication of the desire of the Admiralty to see its youngsters enter the Service in the best conditions, which are always better ashore than in hulks, but also indicates the desire to give the engine-room complements the finest possible training—it must be remembered that the naval artificers do a good deal of the work of certificated engineer officers in the merchant service—and to make the very utmost use of their ability. The hulks have served their turn for many years, but it is now generally realised that the objects aimed at are only attainable in well-equipped, up-to-date buildings ashore. That is the real reason why the change has been made. It must be pointed out that the artificers, even while under training, do very useful service to the Navy.

From the point of view of the naval engineer of all ranks, the finest feature of the change is that the new establishment is to be under an Engineer-Captain instead of an executive officer. In the past it must be admitted that the officers holding the position of Inspecting Captain of Mechanical Training Establishments have been very successful. But experience with Keyham Engineering College has proved that an Engineer Captain is fully capable of running the executive and disciplinary side of an establishment concerned only with the engineering branch of the Service, and that branch is naturally anxious to have everything under its own control.

The idea of training youngsters as engine-room artificers from the end of their schooldays started in 1903, when the late Lord Fisher was dissatisfied with the Navy's practice of getting all its engine-room artificers through the shops and factories between the ages of twenty-one and twenty-eight. That practice introduced into the Navy a non-Service element which was very strong, entered with ideas which were not always in accordance with naval practice, and showed a tendency to resent inevitable Service conditions. Fisher had been studying the problem for a good many years before he was in a position to carry his ideas into effect, and had come to the conclusion that the only way to get the best elements into the engine-rooms of H.M. ships was to institute a system of dual entry. Even without the factors already mentioned some change was necessary, owing to the insufficient number of trained men who were coming forward. The direct entries made up the deficiency, and at the same time instituted a healthy competition between the two branches which has produced excellent results.

His plan was to enter boy artificers directly into the Navy alongside those who had experience in the shops, taking them between the ages of fourteen and sixteen and giving them a long and very thorough training before they went afloat. To begin with, the majority were chosen on the nomination of various school authorities, who had the opportunity of knowing the bent of the lads, preference being given to the sons of skilled mechanics who had engineering in their blood.

The scheme was started with the old "Indus" in the Hamoaze at Plymouth, and the "Asia." The former was originally the ironclad battleship "Defence," and she was joined by two contemporary ironclads, the "Bellerophon," which became "Indus II.," and the "Temeraire," which was the "Indus III." They were fine roomy vessels, their hulls stout enough to act as hulks, but were long past useful service as capital ships, fell into Fisher's hated category of ships that could neither fight nor run away, and had the obsolete muzzle-loading guns which had been so bitterly criticised for some years previously. The "Bellerophon" and "Temeraire" were sent up to Palmer's yard on the Tyne to be fitted with every available machine that was likely to be useful, and when the conversion was completed in the spring of 1904 they had excellent accommodation for 200 artificers.

Fisher did not wait to see the success of the first part of his scheme, but took over two other old ironclads, "Invincible" and "Audacious." They had both been recently fitted as port depôt ships for destroyers, the former as H.M.S. "Erebus" at Portland and the latter as H.M.S. "Fisgard" at Felixstowe. Fisher was against the principle of harbour depôt ships, and believed in small craft being able to look after themselves in any ordinary circumstances; but as these two ships had only recently been given a very fine workshop equipment, they suited his training purpose excellently and they were towed round to Portsmouth to become the Fisgard Establishment to carry out the work of the "Indus" in that district. At the same time H.M. Torpedo Depôt Ship "Tenedos," *ex* "Triumph," was towed round from Devonport to Chatham to carry out the same duties in the Medway.

At the end of 1905 the Portsmouth establishment was increased. "Fisgard I." and "Fisgard II." were satisfactory enough, while the "Hindustan" became "Fisgard III." and later the famous "Sultan" was added as "Fisgard IV."

It has to be admitted that the scheme was put into effect in some haste, which, coupled with the rapid development of the machinery side of the Fleet, soon made alterations necessary. Early in 1906 the Admiralty decided that the "Fisgard" at Portsmouth and the "Tenedos" at Chatham should be entrusted with the training of all boy artificers for the Fleet, while the "Indus" devoted her attention principally to mechanicians with a few rather older supernumerary engine-room artificers.

The Captain of the "Fisgard" was to have the title of Inspecting Captain of Mechanical Training Establishments in order to give a definite head to the branch and to ensure uniformity of training in the various centres, while an Engineer Commander was appointed to his staff for technical questions. In choosing the first officer to fill the position, the Admiralty was certainly happy in Commander W. R. Hall, world famous during the war as Rear-Admiral Sir W. R. Hall, the Director of Naval Intelligence. At the same time it was laid down that lads under instruction were to be employed as far as possible on repair and maintenance work, especially in ships in reserve, which not only gave them useful experience, but saved the taxpayer considerable sums.

Although most of Lord Fisher's schemes were very severely criticised by some section or other of the Navy, there was remarkable unanimity on the double-entry system for engine-room artificers, for there was plenty of room in the Service for both divisions, and the direct entry supplied the deficiency when the shop system was not enjoying much popularity, as was frequently the case. But there were still many improvements to be made, and in 1910 there was a general overhaul of the system; the "Indus" was abandoned by the mechanicians to whom she had been almost entirely devoted and returned to the training of artificers and boy artificers; the "Fisgard" remained as she was, while the Chatham establishment was closed altogether and "Tenedos I" was transferred to the "Indus" establishment.

A considerable proportion of the engine-room artificers who served in the fleet during the war went through the "Fisgard" and her consorts, but the two systems still ran side by side perfectly satisfactorily. Those who were trained in the shops before they entered the Service started as chief petty officers after a technical examination, enlisting for a period of twelve years with a chance of promotion to chief engine-room artificer after six. The examination for this promotion was very much akin to that for a second class engineer under the Board of Trade, while pay and pension were sufficient to attract an excellent type of man.

The boy artificers who went through the "Fisgard" and "Indus" were fewer in number and entered by three means. First, by open competitive examination; secondly, by the recommendation of a Commander-in-Chief or high official, which was given almost invariably on Service grounds, such as the applicant being the orphan of a naval man; and thirdly, by competitive examination on the recommendation of certain educational authorities who took a keen interest in the scheme. When the regulations had been shaken down the boy apprentice was accepted at between fifteen and sixteen years of age, with a minimum height of 5ft. 1in. and a chest measurement of 31in. The engagement was to serve with the fleet for twelve years from the age of eighteen, the time spent under training before the entrant's eighteenth birthday not being reckoned, and, naturally enough, the highest standard was demanded in character and physique, while the entrance examination, although it varied according to the number desiring admission, was by no means an easy one.

After the completion of three months' preliminary training the lads were allotted to one of the three trades, either fitter and turner, boilermaker and smith, or coppersmith and moulder, the second group including the apprentices who had entered for the ordnance branch. About four and a-half years were reckoned to be necessary to get all the requisite training, and as they were devoted entirely to the practices of the fleet, the artificer apprentices had a distinct advantage over those who had undergone a longer apprenticeship in shops ashore.

When war broke out there were naturally a good many changes made in the system. For one thing, the shortage of fully trained men made it necessary to cut down the courses and to hurry the lads to sea as soon as they were fit to undertake their duties. Another point was that at the very beginning of hostilities the excellent machinery installed in "Fisgard II." was appreciated as being ideal for a good deal of the repair work required by the Grand Fleet, and she was accordingly ordered up North to the base. Unfortunately, the voyage had to be made in the very worst season, and the poor old ship foundered while being towed down Channel.

She was replaced in the establishment by H.M.S. "Spartiate," one of the big 11,000-ton protected cruisers built at the turn of the century for which nobody had ever contrived to find a practical use. Her only quality was that she was very roomy, which was precisely what was most wanted in the establishment, and accordingly she became "Fisgard I." H.M.S. "Calcutta," originally the battleship "Hercules" of 1868, became "Fisgard II.," while towards the end of the war the famous cruiser "Terrible," whose machinery had proved itself to be completely worn out when she was put on trooping service to the Dardanelles, became a tender to the establishment, and was later renamed "Fisgard III.," replacing an old wooden line-of-battleship that was quite unsuitable for the work. The former ironclad "Sultan" remained as "Fisgard IV."

After the war the scope of the establishment was increased, both in the training of the artificers and also in outside work which it undertook. Stokers were drafted on board to learn the driving and management of the motor boats which were being supplied to H.M. ships in increasing numbers, and although it was generally admitted that a three-week course was quite insufficient even with naval methods of intensified training, there is no doubt that good work was done. It was also arranged that openings could be made for a few of the best apprentices to be transferred to Keyham College with the idea of qualifying for a commission. Boy Artificer H. B. Samways was the first to succeed in getting the transfer in January, 1924; he is now Lieutenant (E). In addition, engine-room ratings wishing to take advantage of the vocational training course to get their Board of Trade marine engineer's certificate made use of the facilities offered by the ships.

In 1922 the "Indus" establishment at Devonport was closed down and the staff and apprentices were transferred to the "Fisgard" at Portsmouth, which undertook the whole work. In 1926 it was strongly hinted that the Admiralty intended to transfer the school to a shore establishment at Chatham, a rumour that was confirmed in the following year with a statement that it was due to the rapid decay of the hulks, difficulties of sanitation and hygienic living, and a desire to provide improved machinery for the education of the lads.

The first few to be transferred were put into the Royal Naval Barracks pending the entire reconstruction of the disused naval detention quarters. Unfortunately, the difficulty in getting money through the Estimates prevented the work being done nearly as quickly as had been hoped, but with the excellent work of the boys themselves progress was steady and everything is now ready for the occupation of the new quarters. The "Fisgard IV.," originally "Sultan," was ordered to be prepared for stokers taking the mechanicians' course at Portsmouth, and the apprentices did the work of conversion excellently, but the other ships of the "Fisgard" establishment are destined to be broken up as soon as purchasers can be found for them.

Although it is difficult to get exact figures, it is said on good authority that up to date 30 per cent. of the artificer apprentices who have passed through the "Fisgard" have obtained the rank of warrant officer at least, a considerable number having won commissions. It is a fine record for just over a quarter of a century's work, and it is only right that the name "Fisgard" should be transferred to the new "stone frigate," where there is every chance of doing even better work in the future.

The Status of the Oil-Electric Locomotive.

(*From a Correspondent.*)

THE proposals recently laid before the Government for the wholesale oil-electrification of the British railways at a cost of £150,000,000, in preference to the Weir scheme, are so far in advance of anything hitherto contemplated that it is instructive to investigate upon what technical grounds such a proposition can be seriously considered. Service results over an appreciable period of time form the only reliable basis for such an investigation, and when these are examined a remarkable light is shed upon the *naïveté* of those who would plunge into extensive programmes.

It must be admitted that the Lomonosoff 1-E_o-1 locomotive on the Russian railways—the first high-power oil-electric machine to be constructed—has proved the most successful unit over a substantial period. This is largely due to the exceptional simplicity of the transmission, and to the incorporation of a well-tried prime mover, whose size and weight, however, preclude its use in many instances. It is true that both traction motors and cooling system gave trouble at an early stage, but these were quickly overcome, and since the completion of the trials in 1926 this locomotive has been in regular goods service between Moscow and Kursk, having now some 275,000 miles to its credit.

This successful performance led up to the Soviet decree of September 20th last, that, after 1933, the Krasnovodsk-Stalingrad line should be worked by Diesel traction only. The working of this stretch will more than swallow up the seventy locomotives which, in 1929, the Kolomna Engineering Works were authorised to build in conjunction with M.A.N., as well as the four locomotives now at work or under construction. That this will turn out to be but a "paper" decree is evident from the fact that only two of the above-mentioned seventy locomotives have been completed. The first was turned out in March of this year, and is of the 1-D_o-0 type. Intended for shunting and goods work it embodies an M.A.N. 600 B.H.P. engine, running at 700 r.p.m. It is doubtful whether it will have a large range of action, as, on completion, the axle load was over 20

in place of the estimated figure of 18 metric tons. The second locomotive was due to leave the erecting shop early in November, and is of the 1–D–1 type, with rod drive. The delay and result of the Kolomna activities are, of course, due in a large measure to political interference, which makes the September decree, in turn, little more than a good intention.

The remaining four locomotives are: (*a*) The Lomonosoff oil-electric unit; (*b*) a 1000 B.H.P. Diesel-mechanical locomotive; (*c*) a 1000 B.H.P. 4–10–2 oil-electric locomotive, with 1200 B.H.P. M.A.N. engine, now under construction at Essen; (*d*) a 1500 B.H.P. locomotive with electric transmission, the prime mover consisting of two Sulzer 750 H.P. Diesel engines. This is also under construction at the Krupp works. The old Hackel 1030 H.P. $1–C_o+D_o+C_o–1$ centipede, built by Putiloff in 1924, has not been in service for some years It is noteworthy that for powers below 325 H.P. electric transmission was not even considered by the Soviet authorities, and a number of 120 H.P. shunting locomotives on order are similar to the Deutz mechanical transmission machines in Germany.

As far as Europe is concerned, probably the Danish lines have achieved more success than any with oil-electric locomotives, for while their programme is nothing like so extensive as those projected in Russia and Siam, they have had a number of locomotives and rail-cars in operation over an appreciable period. Little consideration appears to have been given to the power-weight ratio of the machines now running, the two 450 B.H.P. units weighing 55 and 58·9 tons, despite the inclusion, in the second case, of a two-cycle engine.

Although the traffic is of quite a secondary character the reliability of the locomotives has been beyond question, and as a result of their working a further twelve units, in powers up to 1000 B.H.P., have been ordered, and their construction is in an advanced state. One of the 270 B.H.P. locomotives has run over 300,000 miles since being put into service early in 1926. With trains of 100–120 tons weight the fuel consumption over four years averaged 3 lb. per mile, and the maintenance cost 1·5d. per train-mile. Approximately the same fuel consumption has been obtained with the $2–B_o–1$, 450 B.H.P. locomotive when hauling 150 to 160-ton trains between Copenhagen and Korsor, on which line a daily mileage of 275 was for some time maintained.

In America the large number of double-bogie 300 B.H.P. and 600 B.H.P. shunting locomotives, incorporating a heavy Ingersoll-Rand oil engine, seem to have met with a good deal of success, and since 1925 orders have been forthcoming every year. On the whole, the engines have proved reliable, but the speed has been reduced in a number of instances from 600 to 550 r.p.m. to avoid a repetition of broken crank shafts. In the more recent examples fan-cooled radiators and forced-ventilated traction motors have been included. Exceptionally high figures for the hours in service per month have been obtained by some railways, the Chicago and North-Western reporting no less than 492, and the G.N. 400. It would appear that these are isolated cases for one month only, but the Lehigh Valley Railway has obtained an average, over twelve months, of 264 hours. Although high, the cost of some £12,200 for one 300 B.H.P. unit is no greater than quoted in this country for a machine having similar characteristics.

The later shunting locomotives embodying 300 B.H.P. and 400 B.H.P. Westinghouse-Beardmore engines—two of which are in use on the Canadian National—have not been long enough in service to give any reliable data as to the probable life or operating economies, but the 2660 B.H.P. Canadian National locomotive is reported to be doing well, but is not in everyday service. Despite a light-weight engine, however, the power-weight ratio is very poor, and may be traced to the large amount of electrical equipment and to the heavy mechanical portion.

Similar faults are present in those two weighty N.Y.C. engines, the 900 B.H.P. passenger and 750 H.P. freight locomotives. The latter has averaged about 4000 miles per annum, hauling 550-ton trains. The cost of engine repairs is reported to be high, for, although the brake horse-power per cylinder is 133—the engine being rated at 800 B.H.P.—no piston-cooling is provided. The record of the passenger engine is unfortunate, for on the sharply curved Putnam division the main frame was fractured on being fouled by the bogie in a derailment.

In 1925 the Baldwin Locomotive Works constructed a large double-bogie shunting engine, the prime mover being a two-cycle "Knudsen" engine, rated at 1000 B.H.P. Test results show that no more than some 750 H.P. has been obtained at the shaft, and 550 H.P. at the rail. Despite this low power, and the smokiness of the exhaust near the power limit exceptional reliability has always characterised this machine, and it is still in daily service in Baldwin's yard, where it displaces two steam shunting locomotives, each with a crew of three men. The original Ward Leonard control with shunt-wound motors has been altered. While the flexibility of a two-stroke engine is not so great as that of a four-stroke machine, the experience over six years with this locomotive proves that with electrical transmission it is quite sufficient, and that with the call for higher power no trepidation need be felt in adopting the two-stroke principle for oil-electric work.

A further effort by Baldwin's in 1929 resulted in another 1000 B.H.P. shunting locomotive, this time with the B_o+B_o wheel arrangement. Power is provided by a supercharged six-cylinder "Krupp" engine running at 500 r.p.m. Equal distribution of the 120 tons total weight has not been effected, the outer wheels being the more heavily loaded.

Good fortune seems to have attended the introduction of the high-powered locomotive in the Argentine. The two 1200 B.H.P. mobile power-houses constructed by Sulzer and Armstrong, Whitworth in 1929 have given excellent service, and have covered well over 45,000 miles. In normal service the Diesel engines are started and stopped some 200 times per working day. Their success in both suburban and longer distance work has brought orders for three 1700 B.H.P. mobile power-houses, and one 1700 B.H.P. locomotive, which are now being built at Newcastle-upon-Tyne. The principle remains the same as in the earlier machines, but the heavier weight and desire for speeds up to 70 m.p.h. have necessitated an articulated design running on four bogies. It is expected that the locomotive will show a good power-weight ratio, despite the handicap of two 850 B.H.P. engines weighing some 36 lb. per B.H.P.

Satisfactory performance has been obtained from the remaining locomotives in the same country. Following the original M.A.N. 300 B.H.P. locomotive of 1928, the Port of Rosario has ordered three units incorporating 330 B.H.P. Sulzer engines, of the same general type as used on the Southern Railway's 420 B.H.P. baggage car. The latter company's 375 B.H.P. "Beardmore" $B_o–B_o$ main line locomotive has run almost 50,000 miles, and has a reputation for smooth running.

As far as can be ascertained the two Tunisian oil-electric locomotives are still in service over the arid lands of that country. The 120 B.H.P. Atlas Diesel unit has been working traffic since 1924, while the 250 B.H.P. Sulzer vehicle has five years' service to its credit. The traffic is light and slow, but the nature of the country should show up oil traction to the best advantage. Over generally level lines, but with short grades up to 1 in 50, the fuel consumption per trailing-ton-mile has proved to be 0·047 lb. for the small locomotive, and for the larger—on acceptance tests—0·036 lb.

Eighteen months ago the North-Western Railway of India took delivery of two double-bogie locomotives for light passenger traffic, with which some trouble has been experienced with the heating and flashing-over of the motors. The power-weight ratio is very unfavourable, but is brought about by the stipulations governing the design of the mechanical portion.

Siam is going ahead with an extensive programme, but only the four-wheeled 200 B.H.P. locomotive with mechanical transmission, has been in service any length of time. The experience as to steady running gained with the Argentine "Beardmore" machine was borne out on the tests of the six 450 B.H.P. locomotives built by Sulzer-Oerlikon-Henschel. These A1A–A1A units ran very steadily and entered curves smoothly at speeds up to 42 m.p.h., when tried on the Rhaetian Railway last July. The success or otherwise of the 1000 B.H.P. and 1500 B.H.P. locomotives now under construction at Aarhus will do much to make or mar the future of oil-electrification in the Tropics.

Experiences in Japan and Manchuria, while covering only two years, appear to have been encouraging. The Japanese authorities are not, however, convinced of the merits of electric transmission, and are testing a 1000 B.H.P. Diesel-mechanical locomotive having a supercharged "Krupp" engine, similar to that of the second "Baldwin" machine. The South Manchurian Railway has ordered a 700 B.H.P. shunting locomotive with an M.A.N. engine, which is to be tried against the 750 B.H.P. "Sulzer" locomotive delivered some months ago. On test between Winterthur and Romanshorn the latter pulled a 1800-ton train at 16 m.p.h. Weight per unit of power is not a fair method of comparing shunting and main line locomotives, as the former produce a very high maximum tractive effort with a low-power engine. A quick-running engine is not a necessity for shunting work, and experiences in America and elsewhere with engines running at 500–600 r.p.m., and weighing 50 lb. to 90 lb. per B.H.P., show them to be preferable for yard service to those running at 700 r.p.m. and over, whose weight is cut down to 20 lb. to 24 lb. per B.H.P.

Elsewhere nothing of outstanding importance has been done. The F.I.A.T. 440 B.H.P. forerunner of the Argentine mobile power-houses is still working over steep grades in Calabria, after six years' continuous service, while in Austria the 200 B.H.P. "Graz" machines of 1926 are still performing the light duties for which they were designed. The 700 B.H.P. unit incorporating a Büchi supercharger, constructed by the Swiss Locomotive Works, is still in the experimental stage. Under construction in Switzerland are two heavy shunting locomotives for the P.L.M. Railway, while in this country work is proceeding on two shunting and one mixed-traffic locomotive, all of which are expected to be in service within the next nine or ten months.

Consideration of the foregoing shows that the proposals for wholesale oil-electrification, or even an extended application, are not built upon a solid foundation. For shunting work the oil-locomotive may be said to have proved its worth, and when initial cost is brought down a much larger sale may be anticipated; but the popularity of mechanical transmission on the Continent makes it very doubtful whether the extra expense of electrical equipment is worth while in powers below 300 H.P. For main line work, whether passenger or goods, only Russia and the Buenos Aires Great Southern Railway have achieved any success, while for secondary traffic, corresponding to British branch line operation, Denmark alone would be justified in embarking upon an extensive programme of new construction.

Despite the arguments of its protagonists it is obvious that the large oil-electric locomotive is not yet past the experimental stage. The number of failures, and semi-successes, marked against such units is appreciable, but it is significant that in the two cases where main line traffic has been successfully handled, the responsibility for the complete design has been vested in locomotive men.

Leading Characteristics of Oil-electric Locomotives.

Railway.	Service.	Wheel arrangement.	Engine B.H.P.	Engine r.p.m.	Weight in W.O., tons.	Weight per B.H.P.
Russian	Heavy goods	1–E_o–1	1200	450	122·0	228
Russian	Shunting	1–D_o–0	600	700	97·0	360
Russian	Heavy goods	2–E_o–1[1]	1500[3]	650	138·0	206
Danish State	Light passenger	2–B_o–1	450	800	55·0	274
Danish State	Light passenger	A1A–2	450[3]	600	58·5	291
Danish State	Passenger	2–D_o–1[1]	1000[3]	—	96·0	215
U.S.A. (various)	Shunting	B_o–B_o	300	600	53·5	400
U.S.A. (various)	Shunting	B_o–B_o	600[5]	600	88·0	330
Western Electric	Shunting	B_o–B_o	300	800	51·75	386
New York Central	Passenger	2–D_o–2	900	310	161·0	402
New York Central	Freight	2–D_o–2	800	600	131·0	368
Baldwin	Shunting	A1A–A1A	[3]1000[3]	450	123·0	275
Baldwin	Shunting	B_o+B_o	1000	500	120·0	268
Canadian National	Shunting	B_o+B_o	400	900	62·5	350
Canadian National	Passenger and freight	2D_o1–1D_o2	2660[5]	800	290·0	244
Buenos Aires Southern	Passenger[4]	1–A2A–1	1200[5]	700	83·0	155
Buenos Aires Southern	Passenger	B_o–B_o	375	700	62·0	370
Buenos Aires Southern	Passenger	B_o–B_o	420	650	53·0[6]	277
Buenos Aires Southern	Passenger[4]	1A–2–2–A1[1]	1700[5]	550	120·0	158
Buenos Aires Southern	Passenger	B_o–B_o–B_o–B_o[1]	1700[5]	550	140·0	185
Port of Rosario	Shunting	B_o–B_o[1]	330	700	55·0	372
Tunis Railways	Light mixed	B_o–B_o	120	500	29·5	550
Tunis Railways	Light mixed	B_o–B_o	250	550	39·0	350
N.W. of India	Light passenger	B_o–B_o	350	900	48·0	370
Siamese State	Mixed traffic	A1A–A1A	450	700	59·0	294
Siamese State	Passenger	2–D_o–2[1]	1000[5]	800	90·0	202
Siamese State	Express goods	2–D_o–D_o–2[1]	1500[5]	—	125·0	187
Japanese State	Goods and shunting	1–C–1	600	700	58·5	218
South Manchurian	Shunting	B_o–B_o	750	650	74·0	221
South Manchurian	Shunting	B_o–B_o[1]	700	700	70·0	224
Mediterranean (It.)	Passenger[4]	B_o–B_o	440[3]	500	47·5	241

[1] Under construction. [3] Two-cycle engine. [3] 750 B.H.P. maximum obtained. [4] Mobile power-house. [5] Double power unit. [6] Portion of locomotive carries baggage.

New Film Studios at Ealing.

THE important part which science and engineering play in the entertainment world is well exemplified in the equipment of the new studios of Associated Radio Pictures, Ltd., recently opened at Ealing Green. Few who visit the cinema realise how much painstaking work is involved in the production of talking films; fewer, perhaps, fully appreciate how much the industry owes to the scientist and engineer. Full advantage has been taken at Ealing of the most up-to-date developments, and the studios compare favourably with the best that Hollywood can show. A few months ago the buildings were a good way from complete, yet when we paid a second visit a little before Christmas the business of making pictures was in full swing. A very fine canteen had sprung into

existence for the artists and general staff. The offices, workshops and other subsidiary buildings were complete, and everything seemed to be working as smoothly as could be desired. Film making in these days is a truly wonderful affair, which many would no doubt give much to see. Apart from the artist, the business gives employment to many highly skilled people engaged in various branches of the work. The life scenes which are introduced for photographic and sound reproduction purposes and which cover all fields of existence often call for great ingenuity. Many branches of the business do not, of course, come within our scope, but it requires little imagination to see that the production of modern films demands the assistance of many people with widely differing forms of knowledge and skill.

At Ealing, where electric power is generated on the premises by two 400-kW and one 150-kW oil engine sets and where much electrical equipment has to be looked after, there is a proper engineering staff apart from the sound engineer and other technical people, such as the chief camera man and his assistants. There is an engineering shop with lathes and other metal working machinery, an electricians' shop, large wood-working and plasterers' shops, a painters' shop, and a scene painters' studio. There are two property rooms and, of course, dressing rooms, and each "star" artist has a private bathroom. For the camera department three rooms had been allocated at the time of our visit—an equipment room for the storage of camera heads and other valuable apparatus, a loading room in which all film is loaded into the magazines, and a room for developing, printing, and testing. Among the subsidiary buildings is also a large rehearsal hall with a waiting room, which is of great value in the way of freeing the floor of the studio. The administration block shown in Fig. 1, which is situated at the entrance of the property, consists of an old house which has been considerably extended and modernised.

In the design and construction of the buildings very careful attention had to be paid to the elimination of extraneous noises. The No. 1 stage is 130ft. long, 78ft. wide, and 50ft. high, and is built as a steel-framed building with solid brick walls, the wall dividing No. 1 stage from No. 2, which is not yet in service, being carried on insulated foundations in order to avoid the transmission of noise and vibration from one stage to the other. Every precaution has been taken in the construction of No. 1 stage to exclude noise from outside. On the inside of the solid brick walls, which are proof against all ordinary noises, independent partitions of special sound-proof material have been erected all round the studio so as to form an internal shell, and these internal walls are lined in turn with rock wool and quilt or other material which has been found to give good sound-proofing results. The roof is also of special sound-proof construction. Many acoustic tests and measurements were carried out with the help of a new reverberation bridge, and it was found that the period of reverberation was very little more than half a second. The main studio door, which is really composed of two doors, one outside and one inside the large opening in the wall, has been made absolutely sound-proof, for the oil engine generating sets which supply the power are only 30ft. away. Like a fire-proof curtain in a theatre, each door, which is 18ft. square and nearly 7in. thick and weighs over 2 tons, rises and falls in one piece and is operated by an electric motor controlled from the studio. When the doors are in the closed position specially designed mechanism clamp them tightly against the adjoining wall, and on dropping each door automatically opens a flap in the floor and allows the doors to fit tightly into a trench before the floor level.

One of the outstanding features of the studio now in service is that the whole of the wiring is done at the level of the "grid," which consists of a series of wide gangways running lengthways and across the studio at a level of 35ft. above the floor. Besides a 4000-ampère studio switchboard, made by the Park Royal Engineering Company, at four points on the "grid" there are "grid" switchboards designed by the Chief Engineer, Mr. S. G. Double, and made by the same firm, each of these boards having a capacity of 2000 ampères. From these "grid" switchboards current can be supplied to lighting equipment suspended below in various parts of the studio, and the usual litter of cables on the floor is avoided. There is also a portable board on wheels, which by means of jumper cables, &c., can supplement the current supplied by any of the four "grid" boards. All the studio lamps are supplied from the overhead "grid," and are remotely controlled from below; 50 per cent. of the lighting equipment is composed of silent arc lamps, whilst the remainder is incandescent lamp equipment. The arc units range from 10 to 300 ampères, whilst the incandescent units range from the ordinary 500-watt. lamps to lamp houses capable of using 10-kW lamps. Underneath the grid there are runways with pulley blocks for the arrangement of lighting equipment, and for "set" building. The central stage during a preliminary lighting test is shown in Fig. 2, where various types of lighting units are to be seen. Under the studio floor there is a large tank for water and underground scenes.

A notable feature is the remote control "organ" which controls all the essentials in connection with "shooting." Signals on the apparatus inform the man in charge of it that all is set to "shoot," whereupon a wheel is slowly rotated, causing various things to happen automatically—the main door of the studio closes, all the smaller doors are locked, the warning signal is given, the silence indicators are operated, the recording camera is started, and is followed by the picture camera, and finally when the recorder has settled down a light flashes on the desk of the assistant director and indicates that the artists may begin to act. Among other things, the organ can also control the ventilation and heating, and production lighting.

The recording equipment is the latest supplied by the Radio Corporation of America, and the R 4 recorders are the only models of the kind in this country. All the equipment is fitted in a sound-proof booth on the floor. The new directional ribbon microphones, as tested when making the picture "The Water Gipsies," are being used almost entirely, as the employment of this microphone has been found to abolish the rather unpleasant metallic tone often noticeable in present-day sound films. The equipment is also fitted with the special amplifier and masking device necessary for the elimination of ground noise. Precautions against the possibility of breakdown include an elaborate intercommunicating microphone line system which enables a change-over of recording apparatus to be made in the shortest possible time. The sound installation includes a special echo chamber built on the lines of the one used by the B.B.C., which enables the acoustics of the sets to be controlled. The studio has two projection theatres, and the larger one is capable of accommodating a full orchestra. Attached to this theatre is another recording installation which enables recording, re recording, and part-synchronisation to be carried out, and as many as four sound heads can be maintained in perfect synchronism. Two Reo wagons, with the recording equipment built in and capable of a speed of over 60 miles per hour, complete the talkie equipment. These carry a complete studio

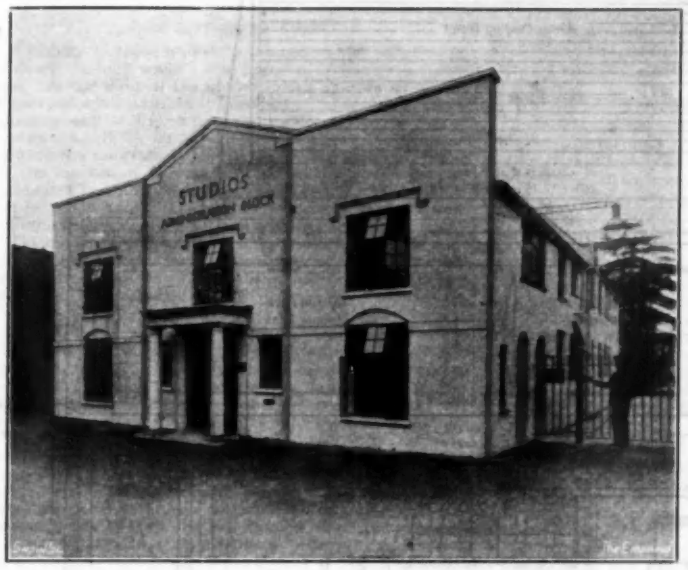


FIG. 1—ADMINISTRATION BUILDING

FIG. 2—LIGHTING TEST ON CENTRE STAGE

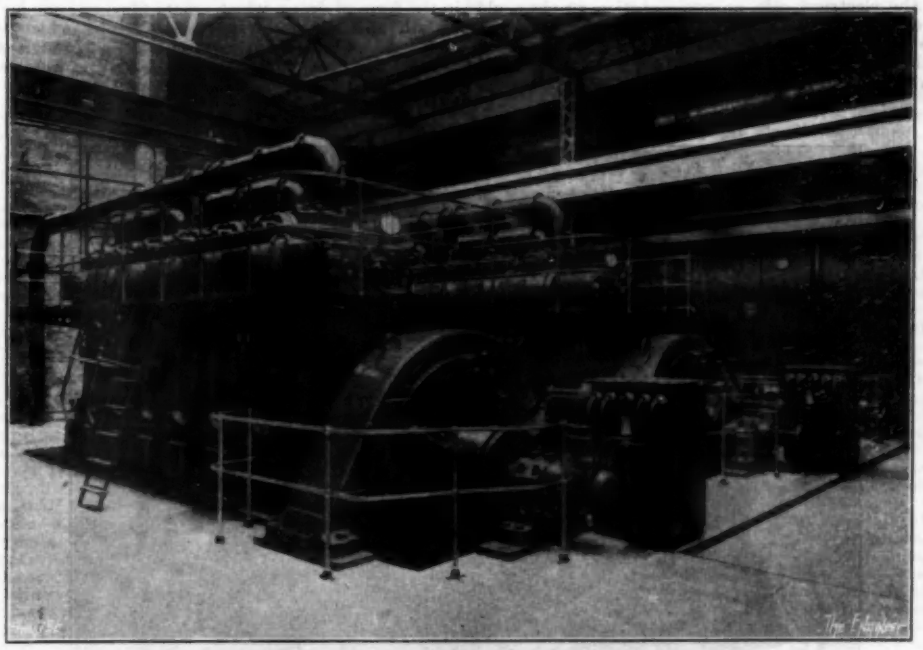


FIG. 3—DIRECT-CURRENT GENERATING SETS

equipment, and a large reflecting type microphone, enabling high quality dialogue to be picked up at a distance of 20ft. or more, and also permitting the picking out of any special effects or speech in crowd scenes.

Notwithstanding the cheap and abundant electricity supply which users of power have been led to expect, after careful consideration it was decided that it would be better and cheaper to generate current on the premises than to draw it from the supply mains. The prime movers favoured were crude oil, solid injection engines, and, as we have said, two 400-kW D.C. sets and one 150-kW three-phase set have been installed. The generating station site is between the heating boiler-house and the studio workshops, and immediately opposite the first studio, a position which, although ideal from the point of view of transmission to the studio, gave rise to the solution of noise and vibration problems. The main engines and auxiliaries shown in Fig. 3 and on page 130 were supplied and erected by Ruston and Hornsby, of Lincoln, whilst the generators and main switchgear—see Fig. 4—were supplied by the General Electric Company, of Birmingham. The three engines, the smallest of which is shown in Fig. 7, are vertical, cold starting, oil engines, working on the makers' airless injection principle. They are started from cold by means of compressed air, and if necessary they can be run up to speed and put on load within one minute. When running at a speed of 300 r.p.m., the two large sets, which have a bore of 15¼in. and a stroke of 20in., are capable of developing 600 B.H.P., whilst the smaller set, which has a bore of 10in. and stroke of 15in., is capable of generating 225 B.H.P. at 375 r.p.m. All the engines have six cylinders. The D.C. G.E.C. generators coupled to the large units are wound for 240 volts, and work across the outers of a three-wire system with static balancers; whilst the G.E.C. alternator coupled to the smaller engine is wound for 415 volts and 50 cycles. The two large D.C. units supply current for studio lighting when the filming is in progress, whilst the smaller set supplies current for lighting the whole premises generally, and for driving the machinery in the various workshops. Incidentally, it is possible by means of suitable switchgear to change over the three-phase A.C. lighting, heating, and power system to the Ealing single-phase supply.

Foundations have been provided for a third 400-kW set, in addition to the three sets that have been installed, and arrangements have been made for all four engines to stand on one large main concrete block resting on cork insulation, so that the transmission of vibration or noise to the adjoining studio or surrounding buildings is entirely eliminated. Rigid tests made with sound and vibration recording apparatus, with a view to detecting vibration or sound resulting from the operation of the engines, have proved highly satisfactory; in fact, the sound technicians are reported to have stated that the conditions were probably the most perfect they have experienced. On the electrical side no commutation ripple could be detected, and noise and vibration were absent. The main concrete block to which we have alluded rests on cork pads, and around the sides of the foundation block are air spaces, the main block being free to move. All pipe connections from the engines have flexible joints, so that the whole plant and foundations are free from the buildings' walls. From each engine the exhaust is taken to one large common pit, and the gases pass from this pit into a brick flue, and thence to atmosphere. In order to isolate any engine when required, the pipes from each engine are provided with a damper.

For cooling purposes, the engine makers have employed a large cooling tower, manufactured by the Premier Cooler and Engineering Company, of Guildford. The cooler, Fig. 5, is an open, natural draught tower cooler, with a capacity of 15,500 gallons per hour, and is capable of cooling this water from 120 deg. to 80 deg. Fah. under usual atmospheric conditions conforming to an air temperature of 55 deg. Fah. and humidity of 75 per cent. The plant operates on the spray and film principle; the water is distributed over the irrigation system as finely as possible in the form of drops, which create films on each layer of lath and ultimately re-form in drops, which fall on to the next layer below, and so on through the tower. The design ensures that the air and water are brought into intimate contact, and that cooling is aided by means of rapid evaporation. Although the heat is dissipated very largely by the evaporation of the water, it is also got rid of to some extent by the heating up of the air when passing through the plant, together with a certain radiation loss. The tower is placed in a large rectangular steel tank mounted on the roof of the power-house, and the cooling water is fed under the action of gravity from the tank round the engine cylinder jackets to a small concrete sump within the engine-room. From this sump motor-driven centrifugal pumps, manufactured by Ruston and Hornsby, Ltd., raise the water to the top of the cooling tower, the water flowing through the tower to the tank to be used over again.

For starting purposes there are two combined engine compressor units, with two mild steel containers, all interconnected so that any engine can be started from either receiver, and either receiver can be charged by either compressor. The compressor unit starts on petrol and runs on paraffin, and has a capacity of 10 cubic feet of free air per minute, when running at a speed of 560 r.p.m. The compressor charges the air receivers to a maximum pressure of 300 lb. per square inch. Both the compressor and engine, which develops 2½ B.H.P., are of the vertical type. The oil is stored in two large cylindrical tanks, each having a capacity of 20 tons, and placed above the 225 B.H.P. engine, so that the oil can flow by gravity to the individual engine service tanks. By the installation of this plant it is expected to save about £4000 per annum, as compared with the cost of taking current from the public supply, a fact which clearly indicates that, in spite of the National scheme, the merits of the private generating plant are not to be ignored.

Besides the engines, Ruston and Hornsby, Ltd., supplied an oil fired flue and return tube heating boiler, constructed on the three pass system, allowing for the outlet to be at the back end. The boiler is 7ft. in diameter and 11ft. 10in. long, and is arranged for setting in the marine style without brickwork setting. The working pressure is 80 lb. per square inch and with feed water at 60 deg. Fah. the boiler is capable of evaporating 3000 lb. of water per hour.

Mr. A. F. B. Anderson, of the firm of architects, Robert Atkinson, which acted for the film company, supervised the building work, which was carried out by C. Miskin and Sons. Smith and Hammond, Ltd., were responsible for all the wiring work, the erection of switchgear in the studio, workshops, &c., and carried out the underground mains work for the production supply, &c. The problem of ventilating the studio without creating noise was dealt with by the architects, the chief engineer, and the contractors for the ventilating equipment, Gorford Bros., Ltd. The woodworking machinery was supplied by J. Sagar and Co., Ltd.

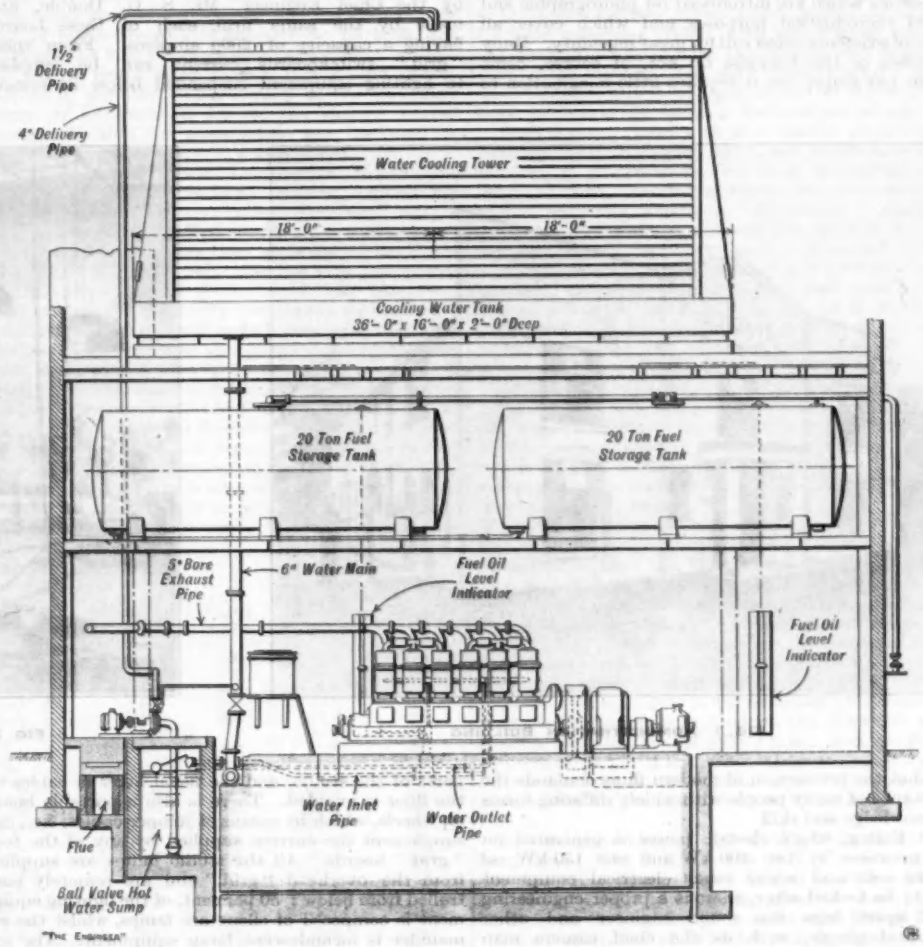


FIG. 5—COOLING TOWER AND FUEL STORAGE TANKS

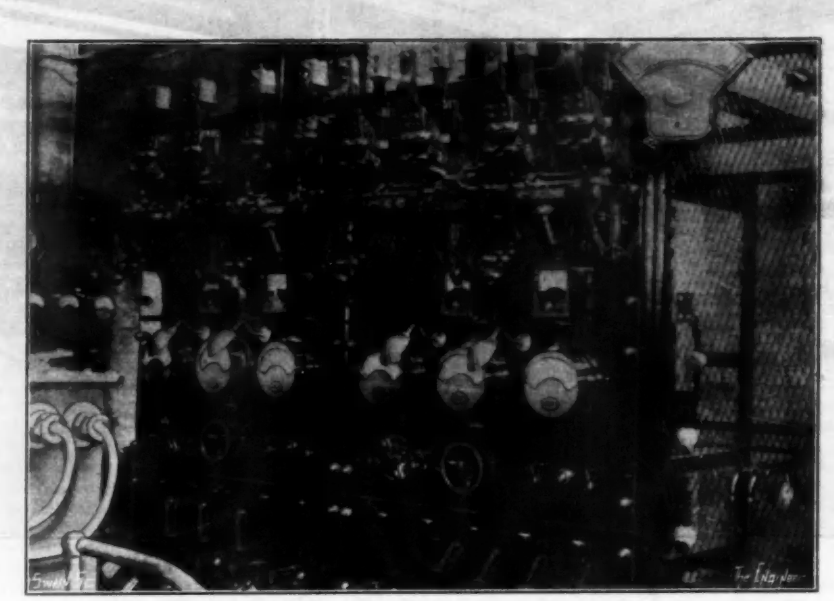


FIG. 4—MAIN D.C. GENERATOR SWITCHGEAR

FARADAY MEDAL.—The Council of the Institution of Electrical Engineers has made the eleventh award of the Faraday Medal to Sir Oliver Lodge, D.Sc., F.R.S., honorary member of the Institution.

THE IRON AND STEEL INSTITUTE: AUTUMN MEETING, 1932.—The Council announces that, owing to the prevailing conditions, it has been decided to postpone the meeting which was to have been held, by invitation of the American Iron and Steel Institute and the American Institute of Mining and Metallurgical Engineers, in the United States in September, 1932. The alternative arrangements for the Autumn Meeting will be communicated to the members as soon as possible.

Building Research.

THE Report* for the year 1930 to the Department of Scientific and Industrial Research of the Building Research Board was published on Saturday last, January 23rd.

The Board draws attention to an increase of over 60 per cent. in the number of inquiries, totalling more than 1000 annually, received from architects, builders, and contractors, which were successfully dealt with during the year by the Building Research Station. The advice of the Station was sought in the solution of an extraordinary variety of problems, including, among others, problems connected with limes, bricks, roofing tiles, floors, plasters, and the keeping of houses and buildings warm in winter and cool in summer.

PENETRATION OF DAMP.

Numbers of these questions related to the penetration of damp through walls. The Director of Research states that "in the light of the knowledge at present available, it does not seem possible to guarantee that a solid brick or masonry wall will exclude damp under all conditions of exposure likely to be experienced in Great Britain. In view of the multiplicity of the waterproofing compounds on the market, it is very difficult to make any general statement, but no preparation is at present known which can be relied upon under all circumstances to waterproof a porous wall without drastically altering its appearance."

The owner of a house with a cavity wall seems to be in a far better position, for it is stated that "no instance has been recorded of the failure of a properly constructed cavity wall to exclude damp."

ACOUSTICS.

A number of inquirers sought advice on the acoustic design of buildings. In many cases it was possible to determine the period of reverberation to be expected in the hall or room under discussion, and, where that was excessive, to suggest the application of sound-absorbing material to some of the wall surfaces so as to reduce undesirable echo effects. The Report points out that the methods of treating a reverberant building by stretching wires across it has been shown to be quite valueless, but that, though experimental data on the transmission of sound through various types of structure are meagre, it is nevertheless now possible to lay down general principles which can be applied to reduce the transmission of sound through floors and partitions. The most useful guide in placing homogeneous material in some order of merit in that respect is their weight. Where the weight of material necessary to obtain the sound insulation required is excessive, a considerable reduction of noise can be obtained by the use of composite structures with air spaces between the component parts.

EFFLORESCENCE.

Everyone knows the unsightly patches, usually white, which frequently appear on brickwork. These patches, or efflorescences, the Report points out, "are due to the presence of soluble salts in the bricks themselves or to soluble salts derived from the mortar or from sources external to the wall." These salts are conveyed by the action of moisture to the face of the brickwork where they crystallise out. The tracking of the cause of efflorescence is, in some cases, extremely difficult. One bad case of efflorescence on the basement wall of a building was traced to a mineral water factory next door, whence sodium sulphate waste, emanating from an obsolete plant for the manufacture of carbonic acid gas, had percolated into the ground in such quantities as to provide a reservoir of salts capable of maintaining an efflorescence almost indefinitely.

Where the amount of soluble salts is limited, washing with water by hand or over long periods by ordinary weathering agencies, appears to be the best remedy for getting rid of efflorescences. A little carelessness with a material, the properties of which were perhaps not well known to the operatives, may bring about serious trouble. The officers of the Research Station were called in to a case in which jointless magnesium oxychloride flooring was being laid on a reinforced concrete landing. A tub of magnesium chloride solution had been allowed to leak on the landing, and while the dense impermeable concrete had prevented the corroding liquid from damaging the reinforcing material, the adjacent brick walls had absorbed the liquid and were damp over a considerable area. "The plaster finish was damp and not only was the plaster-lime soft and useless, but electric switch-boxes and embedded conduits showed signs of corrosion where they were in contact with the solution absorbed by the brickwork." In order to apply decoration successfully it was necessary to hack off the affected plaster work, and to isolate the new plaster from the saturated bricks, while repeated washings had to be applied to the external face of the wall in the hope that the absorbed chloride might be ultimately removed.

FAILURES OF PLASTER CEILINGS.

As in previous years, large numbers of failures of plaster ceilings were examined. "In many instances there can be no doubt," the Report states, "that the work had been executed in a conscientious manner by experienced operatives, and the trouble could only be ascribed to some defect in the materials employed." The existence of such defects is attributed largely to the absence of any formal specification for plastering materials. "The conventional specifications are valueless for all practical purposes as the proportions are not rigidly defined, and it is quite common to see limes specified which are quite unsuitable for the situation in which they are to be used, and which, in any case, could only be obtained with considerable difficulty."

The preparation of standard specifications for building materials is receiving special attention by the Board in conjunction with the British Standards Institution. "The prime function of standard specifications is to provide a standard, as high as economic considerations will allow, which will force inferior material into disuse. . . . The specifications will provide a medium whereby the results of laboratory investigation and full-scale practice can be readily translated into general industrial use."

* Report of the Building Research Board for the year 1930, published by H.M. Stationery Office, price 2s. 6d. net.

CEMENT AND CONCRETE.

Much of the scientific and highly technical work described in the Report is directed towards the development of reliable tests on which such specifications can be based. For example, the conclusion has been reached that the methods at present used for testing the strength of rapid-hardening cement give no reliable indication of the quality of the concrete made from the cement. In view of the importance of the early strength of concrete in modern practice, an investigation has been undertaken in collaboration with the British Standards Institution with the object of finding a simple test for cement which will be a true guide to the strength developed by the concrete.

A large amount of other work on cement and reinforced concrete was carried out, a new laboratory being erected to house that work. A special feature of the laboratory is the plant to enable air conditions, as regards temperature and humidity, to be controlled within narrow limits.

BUILDING REGULATIONS AND BY-LAWS.

Great interest, says the Board, was manifested during the course of the year with regard to building regulations and by-laws. As a body, the Board is not concerned with the drafting of such regulations or with their revision, but it has every desire to promote economy and efficiency in the industry, and it is prepared to give all technical assistance, within its powers, to those bodies and Associations that wish to take advantage of the information and research facilities it can offer. A very satisfactory feature of the work of the Research Station is the extent to which the industry is co-operating financially, and in other ways, with it. Two new co-operative researches were undertaken in conjunction with the Cast Concrete Products Association and the Greystone Lime Burners' Association. Close collaboration was also developed between the Research Station and the Institution of Heating and Ventilating Engineers in connection with work on heating and ventilating problems.

British and Canadian Steel Trade

ADDRESSING the Fellows of the Royal Empire Society at a luncheon held on January 26th, 1932, in the Cannon street Hotel, Colonel Sir Weston Jarvis in the chair, Mr. Julian Piggott, O.B.E., M.C., manager of the British Steel Export Association, said:

"When I first suggested the title for this address our hosts told me that they thought it might be advisable to exclude the words 'Imperial Co-operation.' So much has been written about this subject, and so many speeches have been delivered, all urging the pursuit of this goal, that they feared the subject might begin to pall. Whilst fully sympathising with their desire to avoid an address on a subject which has been only recently so ably discussed by Mr. S. M. Bruce, and others, I felt that the record of an honest attempt on the part of the heavy steel makers to put these ideas to a practical test might be of interest, and also possibly of assistance, to other industries who may be contemplating similar action. It is, I think, now generally admitted that the problem of Empire Free Trade, or, as some people prefer to call it, Imperial Industrial Co-operation, must be tackled in the first instance by industries themselves. Government aid is required in the direction of suitable tariff adjustments on the conclusion of mutually satisfactory agreements between industries.

I should explain how it comes about that the heavy steel makers were in a position to undertake this investigation. At one time it was the fashion to criticise the steel industry for its inefficiency, its obsolete plant, and its antiquated selling methods; but, although forced to carry on through the world depression on the quick-sands of an unprotected home market, the industry has had the foresight and initiative to carry into effect certain corporate policies. In other words, adversity has taught it to think on national rather than individualist lines. One of these activities has been the setting up of an organisation for centralised export sales for the range of steel products demanded by the shipbuilding and structural engineering trades. The British Steel Export Association came into being in October, 1929, with the avowed object, not only of avoiding internal competition as between the various works, but also to put a keen edge on our competitive power on foreign markets. In other words, to secure the maximum export tonnage available. I do not wish to take up too much time with a dissertation on the advantages of combined selling, but it is necessary to emphasise the fact that the Association, representing, as it does, nearly all the leading steel makers of the country, soon found itself in a particularly strong position for negotiation, whether with a foreign buyer, shipping and railway companies, or competitors overseas. In pursuance of its policy of developing export markets, visits were paid to Canada in 1929 and 1930, which opened the eyes of the industry to the possibilities of the Canadian market. The problem then presented itself how best to increase the sales of British steel at the expense of other foreign suppliers, and without injuring the Canadian steel industry. The steel makers as a whole have, for some time, been agreed on a policy of co-operation with Dominion producers, and it remained, therefore, to put this policy to the test and ascertain what reactions were to be anticipated from the Dominions themselves.

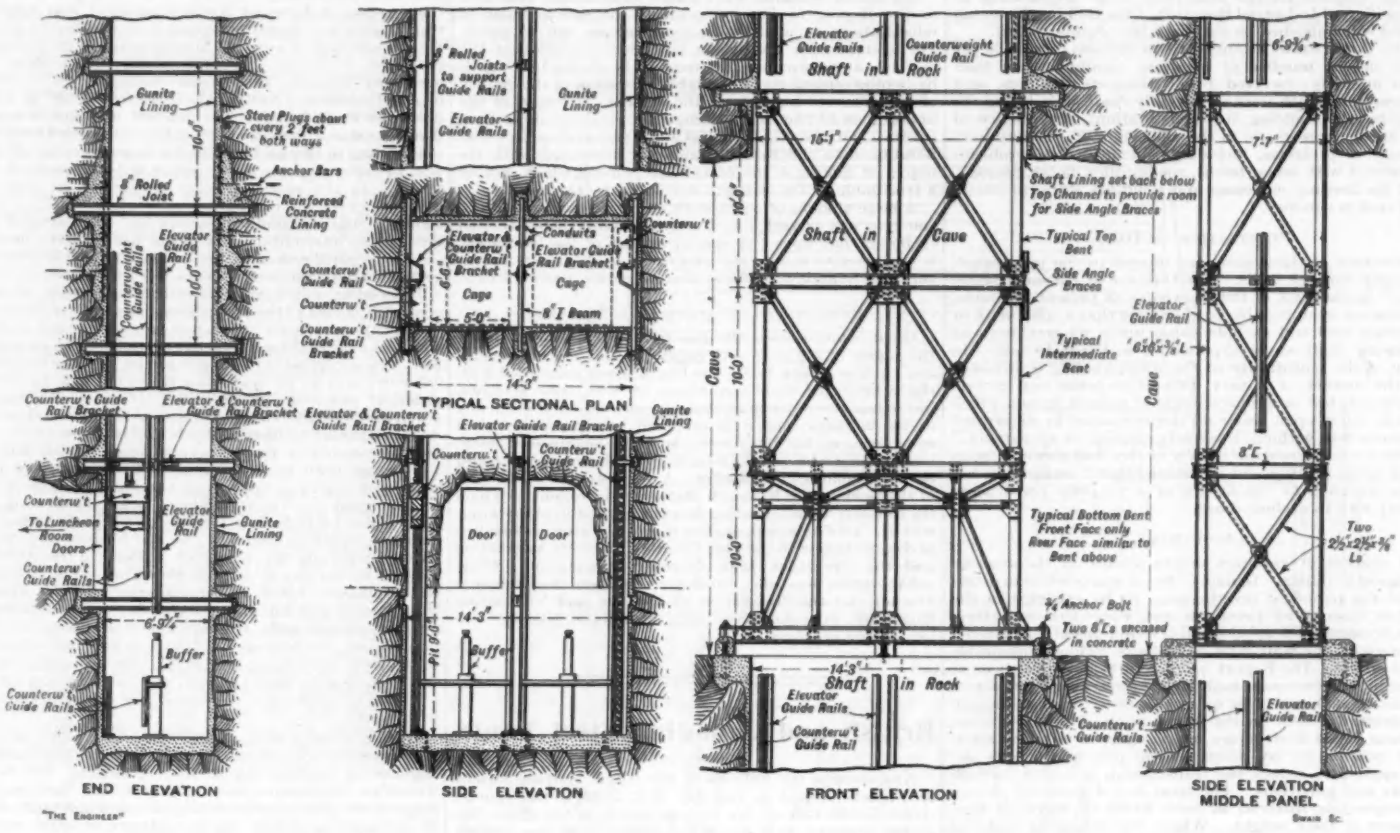
At the beginning of 1931 it was decided that a prolonged visit to Canada should be undertaken, and as manager of the British Steel Export Association I was entrusted with the mission. From the experiences gained on my two previous visits, I had already informed our makers that a policy of non-competition with the Canadian steel works was practicable. The Canadian mills have hitherto limited their production to the lighter sizes of structural sections and plates for which a sufficient demand exists to ensure economic manufacture. The balance of the material used by the structural and engineering industries comprises those heavier lines for the manufacture of which our British mills are peculiarly adapted. It was, therefore, easy to aim from the start at an agreement which preserves light structural steel to the Canadian mills, whilst enlisting their aid in diverting to the United Kingdom as large a proportion as possible of the heavier lines they are forced to import. Now, this policy is itself the essence of Imperial Rationalisation. You have all read in articles innumerable that it should be the aim of British industry to work out in conjunction with Dominion producers a scheme of complementary production. In every-day language this means—recognise the existence of any Dominion industry which is growing up on sound economic lines, and for the products of which adequate demand exists. Aim at enlisting the aid of the Dominions in diverting to British factories the largest possible proportion of those imports which are now being secured elsewhere. In the particular case of Canada an economic demand exists for the lighter sizes about which I have spoken; but consuming centres are so scattered and demand so intermittent that there has hitherto been no economic justification for an expansion of the industry to take care of the heavier lines.

I speedily found that our declared policy of non-competition with the Dominion industry enlisted the sympathy, and even the active assistance, not only of the steel makers themselves, but also of the big consumers and even in highest Government circles. It was necessary, however, in order to consolidate this sentiment, to provide practical proof of our sincerity. It must, I think, be admitted that the British industrialist is viewed with a certain amount of distrust by both the Canadian manufacturer and the Canadian consumer, which distrust will persist until he has convinced the former that he is really not out to compete, and the latter that he is able to give good service. Confidence must be created, and this cannot be done in a few days, for the Canadian has little use, speaking generally, for the business representative who spends the inside of a week in Montreal or Toronto on his way to or from New York. I do not think the six months spent in Canada were wasted. Perhaps the most important thing from the point of view of our half-starved mills at home was to secure as much as possible of the tonnage in heavy rolling mill products which have been going in a steady stream to the United States mills ever since the war, and then, having created a feeling of confidence, discussions on co-operation could be initiated.

During these post-war years American steel interests had entrenched themselves firmly in Canada. The Canadian engineering student learns from American text-books. American architects and engineers are permanently resident in Canada, or are ready to visit important centres at twenty-four hours' notice. American steel makers have provided the Canadian consumer with an unrivalled service, and owing to the proximity of the American mills rapid delivery can be guaranteed. Special Lake freighters and railway cars have been constructed to facilitate the transport of steel in all its various shapes and sizes. I will go so far as to say that it would have been well-nigh impossible for the dozen or more British mills, separated from the Canadian consuming centres by anything from 3000 to 6000 miles of land and sea, to tackle the market with any prospect of real success if they had not agreed to sell on a co-operative basis; but it speaks much for Canadian loyalty to the Old Country, and to the care and attention paid in the execution of the orders by the British steel makers themselves, that the British share of Canada's imports of heavy structural steel has risen from about 3 per cent. in 1928 to 25 per cent. in 1931. We hope for even better figures in the future. These may not sound very striking results, but you should remember that Canada with, perhaps, the most highly developed and successful of our industrial competitors lying along her southern border, is, for that reason, an exceptionally difficult market, and therefore differs completely from the other Dominions. For geographical reasons alone, Canada must always get some of the steel she requires from the United States.

Speaking personally, I must admit that the feeling of being supported by the entire industry at home enabled me to tackle the market without fear of British competition, and greatly facilitated my task, and I should like to pay a tribute to our British mills for the way in which they responded to repeated admonitions that the service we give must be as good as that hitherto provided by our American competitors. Having convinced the Canadian buyer that British steel was every whit as good as anything in the world, and that despite handicaps in transportation we could still be relied upon to deliver the goods, I turned my attention to the problem of rationalisation and discussed with the leading Canadian producers close working agreements. I found at the outset that this was going to be a more difficult job than it would have been had the Canadian steel industry combined to the same extent as the British and there had been one Central Steel Council. There are four main steel producers in Canada, but apart from general understandings as to price, there exists little or no co-operation between them, and one had, therefore, to approach them individually. I received the most cordial welcome from them all. In some cases there was found to be little or no competition, in others it was possible to make some slight adjustment in our quotations so as to ensure no overlap, and a close working agreement on sales policy was evolved. Minor difficulties are unavoidable in negotiations of this nature, and I do not wish to convey the impression that it was all plain sailing, but from the experiences gained during my nine months' stay in the Dominion I am firmly convinced that agreement on complementary production is not only possible, but desirable from the Canadian and British points of view. The necessary preliminary as may have been gathered from my opening remarks, is the establishment, if not of a National Council for each individual industry, then at least of a co-operative selling Association for the Canadian market authorised to speak for the industry. A boldly proclaimed policy of non-competition with the Canadian industry, backed up by actual practice, will open most doors, and agreement on complementary lines follows as a matter of course. I do not wish to exaggerate the results of our activities in Canada. Our Association represents as yet only a portion of the steel output of Great Britain, and orders received form only a percentage of the total steel imports of Canada. What I have endeavoured to show is that the policy we have pursued is practical, and is an instance of what can be

DETAILS OF A 750-FOOT LIFT-SHAFT AT CARLSBAD, NEW MEXICO



done if the problem is tackled in an honest spirit of give and take. The heavy steel industry of Great Britain can, I think, fairly claim to have blazed a trail."

A 750-Foot Lift for Tourists.

AMONG the many natural wonders of the United States which are protected, developed, and cared for by the Government in the interest of the people are the vast caverns near Carlsbad, New Mexico, which are now made free from private exploitation and rendered accessible for visitors by the establishment of a national park which includes the area underlaid by the caverns. A gravel road 30 miles long extends from the nearest railway, but access to the entrance has been by steep mountain trails, involving heavy climbing. In order to provide greater convenience and comfort for visitors, the Government is having a shaft sunk 750ft. deep from the surface to the floor of one of the chambers, and in that shaft there will be two high-speed electric lifts.

Although these caverns have been known for some time, it is only within the past two years that they have been explored and opened to the general public. In 1930 they were inspected by nearly 100,000 persons, while many more tourists would have made the trip but for the difficulties and discomforts involved. A view in one of the numerous chambers, the "Temple of the Sun," 750ft. underground, with its enormous stalactites and stalagmites, is shown in the engraving.

The shaft, which is rather more than 750ft. deep and mainly in hard rock, measures 6ft. 10in. by 14ft. 3in. inside the concrete lining, and will accommodate two lifts or cages with platforms 5ft. by 6½ft. Its construction is shown above. The lining, which is intended mainly to prevent the fall of loose pieces of rock, consists partly of plain gunite applied under pressure from a cement gun and partly gunite reinforced by wire mesh secured by steel plugs or expansion bolts set in holes drilled in the rock. These plugs are spaced 2ft. apart in each direction and are of lengths equal to three times the thickness of the lining. Where the rock is friable and greater thickness of lining is required reinforced concrete will be used. In such places the network of steel rods near the surface of the concrete will be anchored at intervals by horizontal hook bolts grouted in drilled holes, the length of bolt being equal to three times the thickness of the concrete. As the lining was carried on simultaneously with the sinking of the shaft a quick-setting cement was used, so that excavation might be continued safely without interruption and without fear of injury to the men by falling fragments of rock.

In order to expedite the work of construction the shaft was driven from both ends. The raise from the cavern was the usual shrinkage stope used in mining, a timbered manway being carried up, with stalls and the loading chute kept full of the excavated rock. This raise was at first the full size of the shaft, but after getting up for some distance it was reduced to a "pioneer" size until it broke through into the shaft as sunk from above. The sinking was then continued, enlarging the raise to full size.

Struts of horizontal rolled joists were set in pockets cut in the rock and then concreted, these struts forming the attachments for the rolled 15-lb. tee bars which serve as the vertical guide rails of the lift cages. Where caves or caverns were encountered by the shaft steel framing was necessary to carry the guide rails. Typical construction for such framing is shown in the drawing. Two 6in. water pipes and a 2in. pipe are carried the full depth of the shaft, as well as conduits for electric power and telephone service. At the bottom landing shaft doors open into a corridor leading to a waiting room and luncheon room, for the convenience of persons waiting for the cavern guides or waiting to be taken to the surface.

The two lifts will be independent of one another and self-contained, each having its own cage, counterweight system, machinery and a 60 H.P. electric motor. Each cage or car is 5ft. by 6½ft. at the floor, with accommodation for twelve passengers, and is designed for a load of 2000 lb. The speed is to be 700ft. per minute, so that the trip will be made in a little more than a minute. A three-storey

"THE TEMPLE OF THE SUN"

steel-frame shaft house with concrete floor and walls, and of attractive appearance, will contain ticket offices, waiting-rooms, lift entrance and a restaurant on the first or ground floor. Park offices will occupy the second floor, and the lift machinery will be on the third floor. The roof will be built as an observation gallery, affording an extensive view of the wild scenery in the neighbourhood.

THE harbour of Vizagapatam, Madras, is being dredged to accommodate vessels of 28ft. 6in. draught. It is expected that the work will be completed in 1933.

Lloyd's Register of Shipping.

ANNUAL SUMMARY.

THE annual summary of the mercantile shipbuilding of the world for the year 1931 was published on January 27th, and, as usual, we give in what follows the gist of its principal contents. This summary, it will be remembered, does not include warships, and it takes into account only merchant vessels of 100 tons gross and upwards that were launched in 1931, whether they were completed during the year or are still under construction. Sailing vessels fitted with auxiliary power are included with steamers or motorships, according to type of engine.

GREAT BRITAIN AND IRELAND.

Particulars of Total Output.—During the year 1931 there were launched in Great Britain and Ireland 148 merchant vessels of 502,487 tons—viz., 98 steamers of 269,954 tons, 37 motorships of 227,910 tons, and 13 barges of 4623 tons. All these vessels were built of steel. The output for the year was 976,076 tons lower than that for the year 1930, and was the lowest recorded since the first issue, in 1888, of Lloyd's Register Shipbuilding Returns. The lowest totals during that period were the following:—1888, 838,000 tons; 1893, 836,000 tons; 1915, 651,000 tons; 1916, 608,000 tons; 1923, 646,000 tons; 1926, 640,000 tons. The 1931 total represented 31·1 per cent. of the world's output, as compared with 51·2 per cent. in 1930, 54·5 per cent. for 1929, 53·6 per cent. for both 1928 and 1927, and 58 per cent. in 1913.

Nationality of Vessels Launched.—Of the tonnage launched, 298,106 tons were for registration in Great Britain and Ireland, and 204,381 tons—40·7 per cent. of the total tonnage—were for owners residing abroad. This percentage is the highest ever recorded by the Society with the exception of 1930, when 44 per cent. of the output of Great Britain and Ireland was intended for registration abroad. The percentages for the previous five years were:—17·1 per cent. in 1929, 20·2 per cent. in 1928, 21·8 per cent. in 1927, 14 per cent. in 1926, and under 16½ per cent. in 1925. Of the total 95,571 tons were for Norway, and 65,371 tons for the British Dominions overseas.

Size and Type of Vessels.—The returns show that 27 vessels of between 5000 and 10,000 tons each, and 11 vessels of 10,000 tons and upwards, were launched. The largest was the twin-screw motorship "Georgic," of about 27,000 tons, launched at Belfast. Three steamers of over 20,000 tons each, all fitted with turbo-electric machinery, were launched, viz.: The twin-screw "Strathnaver," 22,547 tons, and the twin-screw "Strathaird," 22,544 tons, both launched at Barrow, and the quadruple-screw "Monarch of Bermuda," 22,424 tons, launched at Newcastle. The following six vessels of over 14,000 tons each were also launched, viz.: s.s. "Kosmos II." (16,266 tons), s.s. "Svend Foyn" (14,577 tons), s.s. "Vestfold" (14,577 tons), whale oil tankers; s.s. "Carthage" (14,500 tons), s.s. "Corfu" (14,500 tons), turbine passenger vessels; m.s. "Highland Patriot" (14,130 tons), motor passenger vessel.

Excluding vessels of less than 1000 tons, 30 vessels of 242,222 tons—nine steamers, of 77,243 tons, and 21 motorships, of 164,979 tons—for the carriage of oil in bulk, were launched during the year. All the nine steam tankers will use oil as fuel for their boilers. Of the tankers 12, of about 95,000 tons, were built on the Isherwood system of longitudinal framing. The totals include 14 vessels of 102,121 tons for registration in Great Britain

and Ireland, and 16 of 140,101 tons for other countries, including nine of 95,571 tons for Norwegian owners. Including four small vessels, of 1710 tons, the total tanker tonnage amounted to 243,932 tons, and represented over 48·5 per cent. of the total output for the year 1931. That percentage is the highest ever recorded. The total tonnage of steamers fitted for burning oil fuel, launched during the year, amounted to nearly 210,000 tons.

The returns include three yachts, and a large number of vessels designed for channel, coasting, fishing—24 vessels—towing—14 vessels—harbour service, and other special purposes.

The average tonnage of steamers and motorships launched during the year was 3688 tons. If the vessels of less than 500 tons were to be excluded, the average would be increased to 5760 tons, as compared with 4656 in 1930, 4443 in 1929, 4656 in 1928, 4193 in 1927, 4486 in 1926, and 4439 in 1925.

Vessels Fitted with Turbines.—During 1931, 12 vessels with a total tonnage of 117,550 tons were launched, which will be fitted with steam turbines. These figures include four vessels, of 73,623 tons, for which electric drive has been adopted; in addition, two vessels, of 16,176 tons, were fitted with a combination of reciprocating engines and steam turbines.

Vessels Fitted with Internal Combustion Engines.—The tonnage of vessels fitted with internal combustion engines launched during 1931 amounted to 227,910 tons, which is equivalent to more than 84 per cent. of the steam tonnage launched. That percentage has only been exceeded once, viz., in 1930, when the motorship tonnage was 47,000 tons more than the steam tonnage launched during that year.

The largest motorship launched during 1931 was the "Georgic," of about 27,000 tons—the largest vessel launched in Great Britain and Ireland during the year, and the largest motorship launched in the world during the year. It may be of interest to note that while the average gross tonnage of the steamers of 500 tons gross and upwards launched during 1931 was 4778 tons, the similar average for motorships reached 7527 tons. It may also be stated that of the 35 vessels of 6000 tons and upwards launched during the year, 23 were motorships.

Output of Principal Ports.—The Clyde district occupied first place among the shipbuilding centres, showing an output of 148,392 tons. Then followed the Tyne—120,992 tons—Belfast—78,272 tons—Barrow—51,199 tons—and the Tees—38,990 tons. The only port at which an increase, as compared with 1930, took place was Barrow, the figures for which were 34,757 tons higher than those for the previous year. Enormous decreases were recorded in every other district. The figures for the Clyde showed a decrease of 359,897 tons, for the Tyne of 202,758 tons, for the Wear of 164,492 tons, for Belfast of 90,334 tons, for the Tees of 72,426 tons, and for the Mersey of 47,676 tons.

Progress of Shipbuilding during the Year.—As regards the activity of the shipbuilding industry during the course of 1931, the Quarterly Returns showed that, at the opening of the year, 908,902 tons were under construction in Great Britain and Ireland. The Returns issued during the year showed a steady and rapid decrease, the figures for the end of December—400,505 tons—showing a decrease of no less than 508,397 tons, as compared with the tonnage building at the beginning of the year. The tonnage in hand at the end of 1931 was the lowest recorded since September, 1887. The tonnage begun during the year was about 200,000 tons, which is about 302,000 tons less than the tonnage launched during the same period from the yards in Great Britain and Ireland. Although during the last quarter of 1931 the tonnage begun was greater than the combined total for the previous three quarters, having regard to the work in hand at the end of December, and in view of the great scarcity of new orders during the past year, it would appear that there is still little prospect of any early improvement in the position of the shipbuilding industry of this country.

Other Countries.

Particulars of Total Output.—From the statistics given it appears that there were launched abroad during the year 448 merchant vessels of 1,114,628 tons—139 steamers of 413,102 tons, 295 motorships of 692,585 tons, and 14 sailing vessels and barges of 8941 tons. These figures do not include the tonnage launched in Russia, concerning which country complete information is not available. The total figures showed a net decrease of 296,281 tons as compared with those for 1930. Notable increases were shown in two countries, viz.: Italy, 77,339 tons, and Spain 22,904 tons; while in Germany there was a decrease of 141,623 tons, in Japan of 67,551 tons, and in the United States of 40,822 tons.

Size and Type of Vessels.—The returns for the year included 18 vessels of between 4000 and 6000 tons each; 33 of between 6000 and 8000 tons; 32 of between 8000 and 10,000 tons, and 15 of over 10,000 tons each, the largest being the turbine steamers "Rex"—50,100 tons—and "Conte di Savoia"—46,000 tons—launched in Italy, "Manhattan"—30,000 tons—launched in the United States, and "Champlain"—28,912 tons—launched in France. There were launched during the year 21 vessels of a total tonnage of 302,415 to be fitted with turbines. This total includes five vessels of 51,936 tons, in which the turbines are used in conjunction with electric motors. In addition, five vessels of 10,302 tons which have a combination of reciprocating steam engines and low-pressure turbines were launched.

Excluding vessels of less than 1000 tons, the output abroad for the year also comprised 55 vessels of 400,285 tons built for the carriage of oil in bulk. Twenty of these vessels, of 165,446 tons, are built on the Isherwood system of longitudinal framing. Of the 55 tankers, 52 of 388,157 tons are fitted with oil engines.

During 1931 there were launched 295 vessels of 692,585 tons to be fitted with internal combustion engines, as compared with 280 of 823,712 tons in 1930. Sixty-three of those launched during the year are of over 6000 tons each, including seven of 10,000 tons and upwards. Of those exceeding 6000 tons, 13 were launched in Sweden, 11 each in Denmark and Holland, and eight in Germany. The two largest are one of about 20,000 tons built in Italy and one of about 15,500 tons built in France. The total figures for motorships included a few yachts and other sailing vessels fitted with auxiliary power. Of the steam tonnage launched abroad during the year, about 328,000 tons are to be fitted for burning oil fuel. The tonnage of wood vessels included in the year's total was 5678 tons; in 1930 it was 6640 tons and 4903 tons in 1929. With the exception of one sailing vessel of 146 tons, the totals for sailing vessels and barges were composed of barges, dredgers, car ferries, and similar craft.

The countries where an output of 100,000 tons or more has taken place during the year under review are the United States, Italy, Denmark, Holland, Sweden, Germany and France. The totals for these countries amounted to 937,239 tons, and accounted for 84 per cent. of the total output abroad.

United States.

The output in the United States for the year 1931, namely, 205,865 tons, was 40,822 tons lower than that for 1930; it represented 18·5 per cent. of the total output abroad. Of the tonnage launched, 18 steamers of 146,213 tons, and 19 motorships of 45,323 tons, were built on the Atlantic Coast; seven motorships of 3101 tons on the Pacific Coast, and two steamers of 3638 tons on the Great Lakes. The total for the Great Lakes was the smallest recorded since the first issue of Lloyd's Register Shipbuilding Returns.

The largest vessels launched during 1931 were the "Manhattan," a turbine vessel of about 30,000 tons, built at Camden, N.J.; the "President Coolidge," a turbo-electric vessel of 21,936 tons, built at Newport News; the "Mariposa" and the "Monterey," turbine vessels of 18,000 tons each built at Quincy, Mass. Six other vessels of between 8000 and 10,000 tons were launched.

Thirteen turbine steamers of 145,234 tons were launched during the year, including the vessels named above. The total comprises all together five vessels of 51,936 tons, in which electric drive is employed. Internal combustion engine tonnage launched amounted to 48,424, including four motorships of between 8000 and 10,000 tons, and two small Diesel-electric vessels of 841 tons. Of oil tankers of 1000 tons and upwards, five of 37,561 tons were launched, four of which, of 36,027 tons, are to be motorships, and are built on the Isherwood system of longitudinal framing. Of the 20 steamers launched during 1931, 14 of 147,279 tons are to be fitted for burning oil fuel.

Italy.

The total figures for Italy—165,048 tons—were 77,339 tons higher than those for 1930, and were the highest recorded since 1926. The totals included the two largest vessels launched in the world during the year under review, viz.: The quadruple-screw turbine steamers "Rex"—50,100 tons—launched at Genoa, and "Conte di Savoia"—46,000 tons—launched at Trieste. Of the 33 vessels launched, 24 of 107,165 tons were built on the Adriatic Coast. The tonnage of the 13 motorships launched during the year amounted to 59,782 tons. The motorships included the quadruple-screw vessel "Neptunia," of about 20,000 tons, and two vessels of 16,379 tons, intended for carrying oil in bulk. Sixteen vessels of 23,998 tons were launched for other countries.

Denmark.

The tonnage launched during 1931—125,974 tons—was 11,256 tons less than in 1930. The total was again composed mainly of motorship tonnage—116,765 tons—which exceeded the output of motorships in any other country abroad. Nine of the motorships launched range from 6000 to 10,000 tons, and two are between 10,000 and 11,000 tons. During the year nine motor tankers of 71,897 tons were launched, seven of which, of 59,466 tons, were built on the Isherwood system of longitudinal framing. Thirteen vessels, of 69,372 tons, were launched for owners residing in other countries.

Holland.

The total tonnage launched during 1931—120,296—was 32,776 tons lower than the 1930 figures. As usual, the figures did not include craft exclusively intended for river navigation, the total tonnage of which vessels often reaches a high figure. Eleven vessels of between 6000 and 8300 tons each—all motorships—were launched. The totals for the year included 93 motorships of 113,938 tons, which tonnage represents 94¼ per cent. of the total output for this country. Excluding ships of less than 1000 tons, 11 motorships of 65,960 tons, are intended for the carriage of oil in bulk.

Sweden.

The figures for 1931—112,703 tons—were 19,078 tons less than those for 1930, and apart from that year were the highest ever recorded in Sweden. Over 95½ per cent. of the total was composed of motorships—15 of 107,766 tons—of which 13 are of over 6000 tons each, the largest being a tanker of 10,400 tons. The tankers launched—all motorships—amounted to 11 of 87,263 tons, of which five of 41,519 tons were constructed on the Isherwood system of longitudinal framing. It may be stated that nine of the motorships, of 68,163 tons, are intended for other countries.

Germany.

During the year under review, 58 vessels of 103,934 tons were launched in Germany. As compared with the output for 1930, the present figures showed the large decrease of 141,623 tons, equal to over 57½ per cent. The figures included four vessels of 8702 tons to be fitted with a combination of reciprocating steam engines and low-pressure turbines. The total comprised, also, 32 vessels of 79,995 tons, to be fitted with oil engines, eight of which are of between 6000 and 8500 tons. Nine tankers, of 65,881 tons, were launched, only one of which, of 1094 tons, is to be a steamer. The totals included a turbine yacht of 4581 tons, and a Diesel-electric yacht of 2350 tons, both for United States owners.

Of the total output in Germany no less than 40 vessels, of 91,773 tons, equal to 88·3 per cent. of the total output, are intended for other countries.

France.

The output of France for the year—103,419 tons—was 2502 tons more than that for 1930. Five vessels exceeding 9000 tons each were launched, of which the largest are the turbine steamer "Champlain," of 28,912 tons, the motorship "Aramis" of about 15,500 tons, and the turbine steamer "Colombie," of 13,719 tons. Two other turbine steamers, of 7400 tons, were also launched. Of the 15 steamers, of 74,511 tons, launched, eight of 63,114 tons are to be fitted for burning oil fuel.

Japan.

The output for Japan—83,721 tons—showed the large decrease of 67,551 tons as compared with the total for 1930. The 1931 figures comprised 39 motorships of 77,065 tons, including four vessels of between 6000 and 10,000 tons each. The motorship tonnage accounts for 92 per cent. of the total output for the year. Three motorships, of 20,434 tons, were launched for carrying oil in bulk.

Progress of Shipbuilding Abroad During the Year.

In the combined totals for the work in hand in the various countries abroad, a considerable reduction took place during 1931. At the beginning of the year the tonnage under construction amounted to 1,417,184. A steady decrease occurred during the year, and at the end of December the total was 1,003,290 tons, showing a reduction of 413,894 tons as compared with the end of 1930. The figures exclude the tonnage being built in Russia, from which country no returns have been received.

The Returns for the fourth quarter showed that at the end of 1931 the countries abroad having the largest amount of tonnage under construction were:—The United States, 207,837 tons; Italy, 178,287 tons; France, 164,440 tons; Germany, 103,981 tons, and Sweden, 95,380 tons. The countries which showed the largest decreases during the twelve months were:—Germany, 114,234 tons; Holland, 92,212 tons; Denmark, 55,860 tons, and Sweden, 50,370 tons.

The tonnage now under construction abroad is less than at any time since the beginning of 1912, and the tonnage begun during the year was far from sufficient to replace the tonnage launched. These facts show clearly that, taken as a whole, the shipbuilding industry abroad is being seriously influenced by the current world depression, though not to so great a degree as is the case in Great Britain and Ireland.

Summary of World's Output.

The total output in the world during 1931 reached 1,617,115 tons. That figure represents the large decrease of 1,272,357 tons as compared with 1930, and with the exception of the war year 1915, was the lowest recorded since 1909. The output in Great Britain and Ireland represented 31·1 per cent. of the world's output during 1931, as compared with 51·2 in 1930, 54·5 in 1929, and 53·6 per cent. for both 1928 and 1927.

The total launches in the world comprised 24 vessels, of 294,406 tons, to be fitted with steam turbines, nine vessels of 125,559 tons for which the turbo-electric system has been adopted, and seven vessels of 26,478 tons which are to have a combination of steam reciprocating engines and turbines.

During 1931, 332 vessels totalling 920,495 tons in which internal combustion engines are being fitted, were launched. That figure compares with 1,582,994 tons launched in 1930. The present total exceeds by over 237,000 tons the world's output of steam tonnage. In 1930 the motor tonnage launched exceeded the steam tonnage by over 330,000 tons; while in 1929 the motor tonnage launched amounted to 84·4 per cent. of the steam tonnage, in 1928 it was 80·1 per cent. and in 1927, 62·8 per cent. Of the total steam tonnage—683,000 tons—launched in the world, about 538,000 tons refer to steamers fitted for burning oil fuel under the boilers, so that the tonnage depending exclusively upon coal for propulsion is less than 10 per cent. of the world output for 1931.

The tankers of 1000 tons gross and upwards, launched during 1931 amounted to 85 vessels of 642,507 tons, as compared with 889,865 tons in 1930, 324,870 tons in 1929, and 646,851 tons in 1928. Of these 85 vessels, 73 of 553,136 tons are motorships. In addition there were launched 25 small tank vessels, of 12,335 tons, thus making a grand total of 654,842 tons built for the carriage of oil in bulk. These record figures represent 40½ per cent. of the world output for 1931. During 1931 there were launched 32 vessels—of 1000 tons and upwards—of about 260,000 tons, built on the Isherwood system of longitudinal framing, all of which are built for the carriage of oil in bulk. A notable feature of this year's output—as was in the case in 1930—was that while 15 vessels of 16,562 tons were launched in Norway for Norwegian owners, 31 vessels of 252,873 tons were launched in other countries for registration in Norway.

PROCESS STEAM-ELECTRIC PLANT IN AFRICA.

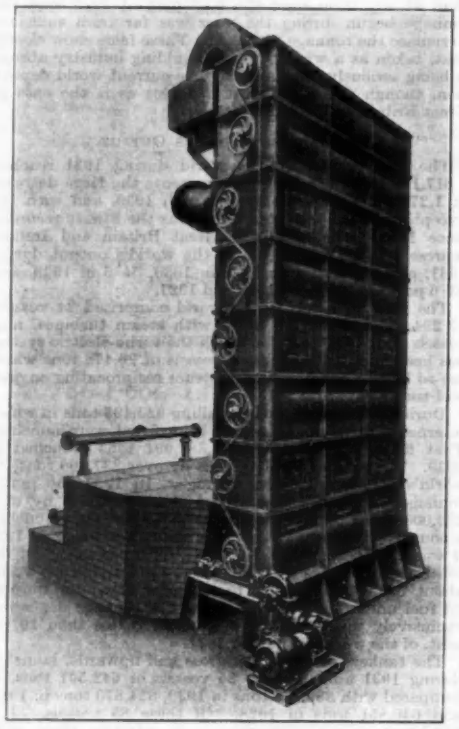
An important memorandum on the subject of electric power and irrigation in the Natal sugar industry has lately been submitted to the Electricity Committee by the Durban borough electrical engineer, Mr. John Roberts, who, according to the *South African Engineer*, for some months past has given close attention to the possibilities of producing electricity in considerable quantities from the process steam used in sugar factories, a portion of the current thus obtained being used for factory purposes, a further portion for irrigation, and the balance delivered to a supply undertaking which would, in turn, provide all the factory's power requirements when its own plant is shut down during the summer months. On the basis of half the 1931–32 estimated output of sugar from mills situated between the Tugela, on the north coast of Natal, and Sezela, on the south coast, 54,000,000 units of electricity would be available over and above that required for factory use, or more than half the number of units sold by the municipality during the past year. Production costs are estimated at from one-tenth to one-eighth of a penny per unit, allowing for interest and plant depreciation. The comparative costs of irrigating 500 acres are shown as £906 per annum with electricity and £1430 with crude oil. Mr. Roberts' proposals comprise the installation of a high-pressure boiler plant working at from 700 lb. to 800 lb.

per square inch, and supplying a turbine plant of about 7500 kilowatts capacity, situated in one of the chief sugar factories on the coast, and operated on similar lines to the existing plant at Hulett's Refineries at Rossburgh, the results of which have proved mutually advantageous to the company and the municipality. As it is necessary for the proposed plant to be installed and in working order by April, 1933, the Town Council has agreed to send the power station superintendent, Mr. Colin Dawson, to England in order confer directly with its consulting engineers, Messrs. Merz and McLellan, who would supervise the manufacture and dispatch of the plant. Mr. Dawson has first-hand knowledge of the local conditions, having been specially selected to study them during the past few months."

A Vertical Coal Dryer.

IN the process of cleaning coal, especially when it is required for coking purposes, it is very generally saturated with moisture, and many efforts have been made to extract this moisture so as to relieve the coke ovens of the necessity for its expulsion before the coking can proceed. Centrifugal machines, and rotary dryers of a type corresponding to a gravel washer, have been tried, but none seem to have met with any very great degree of success. There has, however, been developed an apparatus for this purpose by the Brightside Foundry and Engineering Company, Ltd., of Sheffield. We recently had an opportunity of studying one of these plants in operation at the Barrow Colliery near Barnsley.

In passing we would like to emphasise that a colliery, or such like industry, is not necessarily inimical to its natural



THE BRIGHTSIDE COAL & DRYER

surroundings, for although this pit is in the centre of the park belonging to an old country house, it does not make a scar on the countryside. The ability of modern engineers to avoid nuisance in their activities seems to be growing strongly.

Ordinarily a coke oven plant is decidedly objectionable on account of the fumes it sends out when charging takes place, and this is largely accounted for by the fact that the wetness in the coal has to be dispelled before gasification can be started. There is, too, the incidental expense in the way of heating up the charge to such a point that it will dissipate its moisture.

With the Brightside system the coal is delivered to the retorts in such a condition as has been substantiated by some elaborate tests carried out by Mr. R. A. Mott, of the Department of Fuel Technology of Sheffield University, which are referred to below, that there is not only an increased yield of gas, benzol and tar, but a denser coke is also produced. This latter item is of importance, as the product of this colliery is sent almost exclusively to Barrow for smelting hematite.

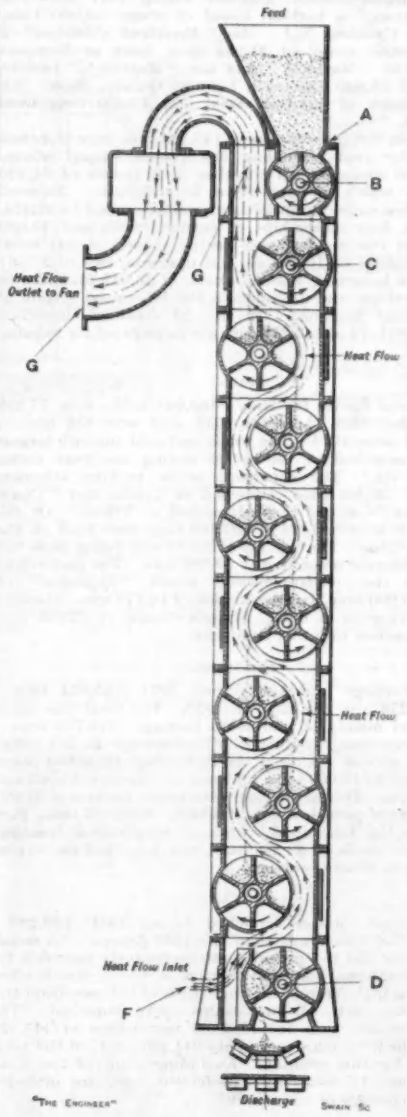
Obviously a comparatively dry coal in the retorts results in a concentrated liquor in the by-products departments of the gasworks and results in an economy there.

The coal drying apparatus, as we saw it at the Barrow Colliery, is a comparatively simple construction, of which we give a drawing. It comprises a narrow cast iron casing, some 24ft. high, in which there are housed a number of rotary cast iron "spiders." These spiders are machined on their periphery and fit snugly against corresponding machined curved faces of the casing for about one-third of their circumference. In view of the fact that the spiders are six-armed, there is, consequently, a complete seal between them and the casing on one side, while there is a free passage way on the other side.

The first spider, B, however, is enveloped on both sides by the casing and is fed with the wet coal from the hopper A. It, consequently, forms a gas-tight seal at the top of the machine. The last spider D, at the bottom, has a corresponding arrangement of sealing at that end. All the spiders are driven by a single continuous chain, which laps partly round sprockets on each of their shafts and is driven by an electric motor. The coal fed into the machine at the hopper cascades gently from one spider to the next below, until it arrives at the bottom, where it is discharged on to any convenient conveyance. At the same time, a draught of hot air is admitted at the bottom of the casing at F, and is sucked out at the top, by a fan, through the duct G, G. This hot draught is generally supplied by burning coke-oven gas in a brick-lined furnace and allowing the whole of the products of combustion to pass up through the dryer.

It will be readily appreciated that by means of the repeated turning over of the coal by the rotary spiders, and by its descent, in contraflow to the ascent of the hot gases, the moisture is effectively evaporated away. The resultant vapour is generally discharged to atmosphere, but it seems that it might still be put to some useful purpose and heat thus economised.

The tests, to which we have already referred, were carried out at Barrow during a week of last summer. The machine has a capacity of 42 tons of coal per hour; it occupies a floor area of 16ft. by 14ft., and requires a head room of 24ft. 6in. The spiders are driven by a motor



SECTION OF DRYER

of 5 horse-power and the fan by a 30 horse-power motor. Both motors are, however, considerably larger than necessary, the actual outputs during the trial amounting to about 2 H.P. and 17 H.P. respectively. The coke-oven gas used for heating purposes had an average gross calorific value of 504·5 B.Th.U. per cubic foot.

The report on the performance of the dryer prepared by Mr. Mott is extensive and contains a large amount of information, but it may be summarised as follows.

The moisture content of the coal entering the dryer averaged 14·62 per cent. at a temperature of 59·6 deg. Fah., and that of the coal leaving at the discharge 9·60 per cent. at a temperature of 143·6 deg. Fah. In other words, 5·56 lb. of water were evaporated out of every 100 lb. of coal entering the machine. For this purpose an average consumption of 20,206 cubic feet of coke-oven gas was required per hour, while the waste gases carried away 2,206,000 B.Th.U. per hour, and the sensible heat left in the dried coal amounted to 2,393,000 B.Th.U. per hour. Expressed in another way, it may be said that the drying of the coal to the extent of 5·56 per cent. of the weight of the raw coal required the expenditure of 2·28 per cent. of that coal. The volatile constituents of the coal were not affected in the least, and the grading as to size hardly at all.

CARE OF BOILERS.—The British Engine Boiler and Electrical Insurance Company, Ltd., of Fennel-street, Manchester, has sent us a copy of a pamphlet on the "Inspection of Water-tube Boilers," which may be cordially recommended to the attention of all boiler attendants. Copies can be obtained on application.

OIL-ELECTRIC RAIL COACH.

FOLLOWING the trials made by Mr. H. N. Gresley over the Newcastle-Blackhill-Durham route of the L.N.E.R. on November 23rd, 1931, further trials of the Armstrong Whitworth oil-electric rail-car—see THE ENGINEER, December 18th, 1931—were made over the York-Whitby-Scarborough route on Wednesday and Thursday of last week, January 20th and 21st, 1932. The speeds obtained on the heaviest gradient at Ravenscar Bank constituted a record, the sustained speed of 23 miles per hour being 5 miles per hour faster than that of any self-propelled vehicle previously run over the route.

On the journey from York to Malton speeds slightly in excess of 60 miles per hour were touched. After leaving Pickering the first gradients were encountered, and on the journey from Levisham to the summit of Goathland, gradients varying from 1 in 49 to 1 in 75 were negotiated at a speed of over 40 miles per hour, which was maintained to the summit. The next serious piece of work was from Whitby Westcliffe to Hawsker, where there is a gradient of 1 in 39 for a quarter of a mile, and a mile at 1 in 43. Here the speed was 25 miles per hour.

The severest test of the route is Ravenscar Bank from Fylinghall to the peak—3 miles at a stiff pull of 1 in 39 for the whole of the distance. A dead stop was made at Fylinghall, and, starting from zero, a speed of 23 miles per hour was quickly obtained and maintained right through the tunnel to the summit.

The whole of the journey from York to Scarborough was undertaken with the engine trailing. At Scarborough the vehicle was turned round to run the engine foremost, and some acceleration tests were made between Scarborough and Malton. Stops took place at Ganton and Knapton, and in each case the test gave identical results. The car achieved a speed of 20 miles per hour in 26 seconds from the start, 30 miles in 46 seconds, and 40 miles in 82 seconds. No special tests were made for deceleration, but the braking power was found to be very good.

There was not the slightest difficulty at any time in starting the engine, which was switched right off at every stop, and when coasting. The consumption of fuel was at the rate of 5 miles per gallon for the round trip, the car averaging 4 miles per gallon on the heaviest gradients and 6 on the flat. The average fuel consumption represents a fuel cost of less than ¾d. per mile, or, including lubricating oil, less than 0·9d. per mile, and there are, of course, no standby losses when the car is standing.

SIXTY YEARS AGO.

THE battle between sail and steam had not been completely won sixty years ago, although, as we know now, the turning point which was to bring victory to steam had been passed. Most of the mercantile marine steamers could, in the event of a breakdown in the engine-room, still show a fair spread of sail. In the Royal Navy, however, a change was taking place. Our first steam war vessels had been full-powered and full-masted, and if one means of propulsion failed, the other was always ready to take its place. With growth in confidence, the Navy sought to rid itself of sails some time before the mercantile marine was fully prepared to follow the same course. In the "Glatton" and "Devastation" the Admiralty produced the first warships wholly dependent upon their engines. Many people argued that it was a great mistake to build masteless ships, but the naval authorities replied that so long as the machinery was carefully protected from shot, the chance of a breakdown was too slight to deserve attention. That argument, so we wrote in our issue of February 2nd, 1872, was good so far as it went, but recent events in the Navy inclined us to doubt whether it could be accepted much longer. The truth was that the engines of our warships were showing a distressing liability to break down. The common trouble was the splitting and cracking of the cylinders. We had in the past reported several incidents of that description, and now we had to record that a very recent addition to the Navy, H.M.S. "Swiftsure," had cracked both her cylinders on her first run from Jarrow to Keyham. The defects were patched, but after further trials the cracks were found to have extended, and new cracks to have appeared. The cylinders, it was decided, were to receive fresh patches, but many people doubted whether by that means they would ever be made satisfactory. We ourselves had no doubt on the point. We were satisfied in our own minds that the trouble was of a fundamental kind, and that it arose partly because of the immense size of the cylinders and partly because they were arranged horizontally. The dimensions of the cylinders employed in those days were remarkable. In the "Hercules," for example, they were 127in. in diameter and 4ft. 6in. in stroke. Cylinders almost as large were in use in the mercantile marine, but they were arranged vertically, and gave little trouble. The Admiralty adopted horizontal cylinders in order to have all the machinery beneath the water line, and thereby to protect it from shot. The huge cylinders arranged horizontally, so we argued, were exposed to contraction and expansion stresses, and, being tied down at each end to a firm base plate, were bound to assume the form of an arch. Failure in these circumstances was, we maintained, inevitable. The remedy consisted either of fixing the cylinders rigidly at one end only, and allowing the other end freedom to move with the expansion and contraction, or of employing vertical cylinders and protecting the machinery above the water line by means of armour plate.

LAUNCH OF H.M. SUBMARINE "THAMES."—We are informed by Vickers-Armstrongs, Ltd., that H.M. submarine "Thames," which was ordered on September 1st, 1930, was successfully launched at the Naval Construction Works, Barrow-in-Furness, on January 26th, by Mrs. Backhouse, the wife of Vice-Admiral R. R. C. Backhouse, the Third Sea Lord and Controller of the Navy. Very few details of the ship are, of course, available for publication, but we may state that this important addition to His Majesty's Navy embodies all the latest improvements in submarine design and construction, evolved by the technical staff of the Admiralty and by the builders, who are recognised throughout the world as one of the leading constructors of submarines.

Railway and Road Matters.

THE popular Newhaven-Dieppe steamship service, jointly owned by the Southern and the French State Railways, is to have another boat. She is to be of the same style as the "Worthing," but with yet more second-class accommodation. The contract has been placed with William Denny and Brothers, Ltd.

BILLS are now before the Irish Free State Senate for the co-ordination of railway and road transport. Railway interests express disappointment at the proposals, inasmuch as, they maintain, all that is to be done is to allow the railways to use the roads along with the road transport people. The Government, on the other hand, says that the railways will then have a chance of becoming owners of a better transport concern.

DURING the three months ended on June 30th last the Assistant Inspecting Officers of the Ministry of Transport held forty-nine inquiries into the more serious accidents to railway servants. Fourteen of these were fatal cases and in six the accident was ascribed as due to misadventure; in five to want of care on the part of the deceased; in one to want of care on the part of a fellow servant; whilst two were classed as accidental.

THE Southern Railway Company is finding that its suburban traffic into and out of Charing Cross is increasing in greater proportion than that using Cannon-street. Within five years the Charing Cross increase has been 31,000, whilst Cannon-street has been 7000. From February 1st three up trains now running into Cannon-street will be diverted to Charing Cross and a similar change will be made in four down trains.

DURING the month of November last 73·73 per cent. of the 81,749 steam-worked trains on the Southern Railway arrived punctually, as compared with 72·71 per cent. of the 85,434 trains in November, 1930. The average late time of the remainder was 1·00 minute, as against 1·03 minutes. There were 86,188 electrically operated trains in the same period of 1931, of which 76·43 per cent. ran to time and the average late running of the remainder was 0·62 minute. In November, 1930, there were 86,140 trains, and the corresponding figures were 70·54 per cent. and 1·03 minute. Again we must mention the excellent results of the goods train working. There were 15,494 trains in November last; the average late departure from the station of origin was 1·7 minutes and 89·4 per cent. arrived punctually.

EARLY in 1928, in connection with the electrification of the lines in the Bombay area, the Great Indian Peninsular Railway equipped the Bombay Harbour Branch with automatic signalling. The length was nearly 9 miles of double line; it was divided into fifteen sections on each road and gave a five minutes' headway. According to an article by Mr. H. E. Cox, the assistant signal and interlocking engineer, the operating costs used to be Rs. 32,124, but in order to have a true comparison, that figure must be increased, in order to provide for an eight-hour day, to Rs. 46,104. To-day the operating cost is Rs. 7812. In considering the maintenance figure it must be remembered that a better grade of maintenance is employed and the whole of the twenty-four hours are covered instead of only nine hours. Maintenance is therefore Rs. 5624, as compared with Rs. 2080. After allowing 6 per cent. interest on the increased capital charges the total gross annual expenditure is Rs. 33,058, as against Rs. 58,529. This saving of Rs. 25,471 is a return of 14·3 per cent. on the investment.

IT came somewhat of a shock to read, in the obituary columns of *The Times* for January 21st, the names of three men who have had distinguished railway careers. Taking them in alphabetical order, there came first Mr. Frederick Arthur Campion, who, to begin with, was the son of Mr. Frederick Campion, one of the two divisional engineers, under the engineer-in-chief, of the Midland Railway, for many years towards the end of last century. Mr. F. A. Campion served the Great Northern, however, and when Mr. T. R. Johnson went to New South Wales as Railway Commissioner, succeeded that gentleman as assistant engineer under Mr. Alexander Ross. On the retirement, at the end of 1909, of Mr. W. H. Miles, he became the chief engineer of the Great Northern (of Ireland), which position he held until his retirement in June, 1929. Following the announcement of Mr. Campion's death came that of Mr. Joseph Davis, who was the consulting engineer in London for the New South Wales Government Railways from 1920 to 1927. Then, with much regret, we came upon the name of Mr. Thomas Monk Newell, who, whilst pre-eminent as a dock engineer, had a railway connection because of his association, from 1889 to 1913, with the railway-owned docks at Hull. Mr. Newell's father was Mr. John Newell, of the firm of Monk and Newell, railway contractors.

FIFTY years ago two fatal railway accidents of a serious nature occurred in the London area which appear to merit mention, in view of the better conditions that now prevail. On January 25th, 1882, a fog came on with such suddenness that the fog signalmen were not on duty at Hornsey, on the Great Northern Railway. A regulation in the rule book—which still stands—provides that, in foggy weather, should the fogmen not be on duty at what are known as advanced starting signals, trains must not be allowed to stand at such signals, but must be kept back at the starting signals, i.e., those near the signal-box and less liable to be overlooked. The driver of a passenger train, knowing this rule, assumed that, when the starting signal was at "clear," his road was open to the next box. That was not so; the advanced starting signal was in work and was at "danger," and his train collided with a previous one and three passengers were killed. Three days later—on the 28th—the draw-bar of a privately owned wagon broke and that wagon and others were derailed. An adjoining line, on which a passenger train was approaching, was obstructed and in the consequent collision five passengers lost their lives. The Inspecting Officer of Railways who inquired into the accident said that the draw-bar was made of iron of very inferior quality. At that time the draw-bars were continuous and served the hooks at each end instead of, as now, being divided. The former practice was condemned in this case.

Notes and Memoranda.

THE plumber holds his "bit" near his face to determine whether or not it is hot enough for a job, and we can remember nurse spitting on a flat iron for the same purpose; but now the chemist is dragged into the problem. The *Chemical Trade Journal* says that in order to save damage to acetate silk fabrics by overheating in ironing, the British Launderers' Research Association has developed a sort of pencil made of benzanilide, which will leave a white mark on an iron not too hot for the work, but will leave no mark if the temperature is above the danger point. The idea seems worthy of extension.

IN the opinion of H. J. N. Riddle, who recently gave a lecture on the subject before the Junior Institution of Engineers, practically all the problems which remain to be solved in connection with moving coil loud speakers are connected with the physical properties of the cone or diaphragm itself, and not with the electro-magnetic portion of the system. It might well be that the solution of the problem of the super efficient loud speaker lies in the abandonment of the electro-magnetic principle, new methods of reproduction in which moving solid bodies, with their inertia characteristics, will be replaced by other methods, such as glow discharge or arc speakers.

HIGH-CHROMIUM irons and steels can, says *Steel*, be welded whether they are in thin gauge sheets, plates, or castings. A neutral flame just large enough to ensure proper fusion should be used, since too much heat causes the molten metal to boil, resulting in a porous weld. A blow-pipe flame with excess acetylene increases the carbon content and will lower the resistance of the joint to corrosion. On the other hand, an excess of oxygen will cause the formation of a quantity of infusible oxide. Welding should be carried through to completion as rapidly as possible. It should nearly always be done on one side only. The welding rod should not be "puddled," because weak, porous welds will result.

SCIENCE and an efficient organisation, states the *Canadian Engineer*, have combined to triumph over the forces of Nature in keeping the 220,000-volt transmission lines of the Hydro-Electric Power Commission of Ontario free from serious interruptions and breakdowns. The transmission lines bring Gatineau power over a distance of 230 miles in order to supply the Niagara system at Toronto. For a period of twenty-three months, from August 17th, 1929, to July 29th, 1931, there was not a single interruption due to 220,000-volt line faults. Up to October 1st of 1931 there was only one interruption to important loads, despite the fact that construction was in progress, necessitating frequent changes and adjustments in protective devices and wiring. In the summer of 1931 lightning storms passed over the eastern lines on at least twenty-five days.

A NEW submarine cable was laid recently between Key West and Havana to provide increased telephone facilities between the United States and Cuba. This is the longest deep sea telephone cable in existence and also is unique in being the longest telephone cable circuit without intermediate repeaters and without inductive loading. The new cable has a single central conductor with concentric tape return, and employs the newly developed material paragutta for insulation. Owing to the smaller dielectric constant and to the smaller leakance, the cable is much smaller in size than any of the three other cables between these countries. A carrier telephone system provides three telephone channels and as ultimately developed a still greater number of facilities may be made available. A large number of noise sources was investigated and the necessary methods for eliminating them were installed.

A LEAFLET just issued by the Department of Scientific and Industrial Research describes dry rot in timber as follows:—The appearance of wood decayed by dry rot depends upon the stage of the attack and upon the conditions under which the fungus is growing. When the fungus is growing actively in a damp situation, such as a wet cellar, it appears upon the wood as white, fluffy, cotton-wool-like masses, and spreads out like a silky white sheet. In rather drier places the fungus forms over the surface of the wood a skin or felt, which soon becomes pearly-grey and usually shows, here and there, tinges of bright lemon yellow and shades of lilac. Branching strings or strands, which vary in diameter from the thickness of a thread to that of a lead pencil, are generally formed. These strands contain tubes which conduct water, and they are capable of penetrating the mortar in a brick wall and can pass over inert substances, such as stone or iron, thus enabling the fungus to spread to other timber nearby. The leaflet, which may be obtained from H.M. Stationery Office, describes measures of precaution against dry rot.

AN abstract of a paper read before the American Institute of Electrical Engineers by Mr. R. M. Baker and published in the January issue of the official *Journal* of that Institute, states that when the parallel type winding was first used on the armatures of large D.C. machines it was almost impossible to obtain sufficiently good magnetic balance of the main field circuits to permit satisfactory operation. In 1896 the idea was conceived of automatically balancing the flux in the main poles by connecting together those points on the armature which normally should be of the same potential. These equalising connections have proved themselves capable of taking care of considerable unbalance in the field; in fact, their performance has been so satisfactory that little study has been given to the details of this action. An increased knowledge of the behaviour of these currents, however, has been secured by an analysis which is unique in that it is based upon experimentally determined curves of variation in equalising current in an actual machine. The analysis shows definitely how these currents act to correct the unbalance causing their flow. It was found that even with very small inequalities of the main pole gaps the equalising current in an armature coil may reach a peak value as high as 25 per cent. of the full load coil current, several times each revolution of the armature. It has been shown also that the oscillograph is very useful in studying the behaviour of equalising connections, and that empirical results are obtainable without much difficulty.

Miscellanea.

ELECTRIC trams on four routes at Hull are to be superseded by omnibuses.

A CZECHO-SLOVAKIAN firm is contemplating the establishment of a glass-making factory in the St. Helens district.

THE Middlesex County Council will not proceed for the time being with schemes for the construction of a new tramway and a new road.

THE Hammersmith Finance Committee has recommended the Borough Council to borrow £99,992 from the Public Works Loan Board for expenditure in extending electrical plant.

IN a recent blast at the Furnace quarries, Loch Fyneside, near Inverary, some 120,000 tons of granite were dislodged at one time. The drilling and boring for the charge occupied about a year.

OPERATIONS are about to be started at the nitrogen fixation plant at Pet, near Varpoloca, in the district of Veszprem, Hungary. The capacity of the factory is 22 tons of ammonia a day.

THE latest reports show that the sales of new motor cars in New Zealand dropped by 58 per cent. during last year. The English share of the imports, however, increased from 22½ per cent. to 39 per cent.

THE Home Office has issued a series of regulations controlling the asbestos industry. The principal object of the regulations is to prevent the spread of asbestos dust, and an exhaust draught must be provided for various machines.

THE nitrogen fixation plant of the Mūke company, in Japan (a subsidiary of the Mitsui interests) has successfully started work and is producing sulphate of ammonia at the rate of 30,000 tons annually. The Claude system is used, with hydrogen from coke-oven gas.

A SYNDICATE of Oslo business men is considering a plan to purchase the old 20,000 tons Cunarder "Carmania," with a view to mooring her alongside the quays at Oslo and renting cabins to homeless families and single men. It is estimated that there would be accommodation for 2000 people.

THE *Daily Telegraph* learns that at Slough, within the last few weeks, no fewer than twenty-five new factory sites have been let, of which twenty have been let to foreign firms. The new manufactures include scents and toilet preparations, dry batteries, safety razors, rubber gloves, textiles. Inquiries for available sites at Slough have risen from three or four to some hundreds each month.

A NEW blast-furnace is undergoing tests at Workington which, it is said, may revolutionise the West Coast hematite pig iron trade, and, incidentally, reduce labour costs very considerably. Embodying the latest improvements in blast-furnace practice, its operations are electrically controlled. The mere pressing of a button automatically operates the charger lifts and lower bells, and empties the skips.

IN accordance with the plans of the Chinese Aviation Administration of the Ministry of War, three aerodromes were completed in Fukien during the early part of December, while two more are now under construction. The former are situated at Foochow, Chuanchow, and Changchow, along the Fukien coast; while the other two are to be at Funing a coastal town in North-Eastern Fukien, and Yenping, in the central part of the province.

THE new lighting system at Piccadilly-circus is to comprise sixteen standards, twelve of which will be 25ft. high. There will be forty lamps, having a total consumption of 60 kW. An emergency service will be supplied by a storage battery, which will be automatically switched in in the event of the main supply from the St. James' and Pall Mall Company failing. The capital cost of the system is £3000 and the running cost, for current, cleaning and maintenance, will be £436.

THE Port of Goole, according to figures supplied by the Aire and Calder Navigation, dealt with just over 2,000,000 tons of coal during 1931. This is a falling off of approximately 13 per cent. compared with the figures of 1930, when 2,542,338 tons were dealt with. Foreign shipments, which amounted to 1,029,952 tons, declined by 28 per cent., the figure for 1930 being 1,475,159 tons. On the other hand, coastwise shipments increased by 15 per cent., the 1931 figure being 962,917 tons, as against 825,634 in 1930. Bunkers accounted for 135,297 tons in 1931, as against 151,545 in 1930.

SOME information regarding the extensions and amalgamations by which the canal system from the Regent's Canal Dock and the Port of London to Leicester is now under one control were given by Mr. W. H. Curtis, director of the Grand Union Canal Company, at a recent informal meeting of the Institution of Civil Engineers. He stated that the policy of his company was to deepen and improve the canals to allow 100-ton barges, with a maximum of 4ft. 6in. draught. His own preference, however, was in favour of 88 and 55-ton barges. In Mr. Curtis's opinion there was no possibility of the efficient operation of linked canal systems unless they were under single control.

THE inaugural meeting of the Engineers' German Circle, to which all interested are cordially invited, will be held at the Institution of Mechanical Engineers in the Reading Room on Monday, February 1st, at 6 p.m. Tea will be provided before the meeting, at 5.15 p.m. Introductory addresses will be delivered on behalf of the Institution of Mechanical Engineers by Mr. Loughnan Pendred, Past-president; by Director E. Kocher, of Siemens-Schuckert (Great Britain), Ltd., on behalf of the Verein deutscher Ingenieure; and by Herr Dr. E. H. Reuter, of the German Embassy; after which Herr Ingenieur Ernst Schneider, of the Maybach Motorenbau, Friedrichshafen, will lecture on "Allgemeine Anwendung von schnellaufenden Verbrennungsmotoren für Land, Wasser, und Luft" (General Application of High-speed Internal Combustion Engines for Land, Water, and Air). The lecture will be illustrated with lantern slides.

POWER PLANT IN FILM STUDIO AT EALING

RUSTON AND HORNSBY LTD., LINCOLN, AND GENERAL ELECTRIC COMPANY LTD., BIRMINGHAM, ENGINEERS

(*For description see page* 122)

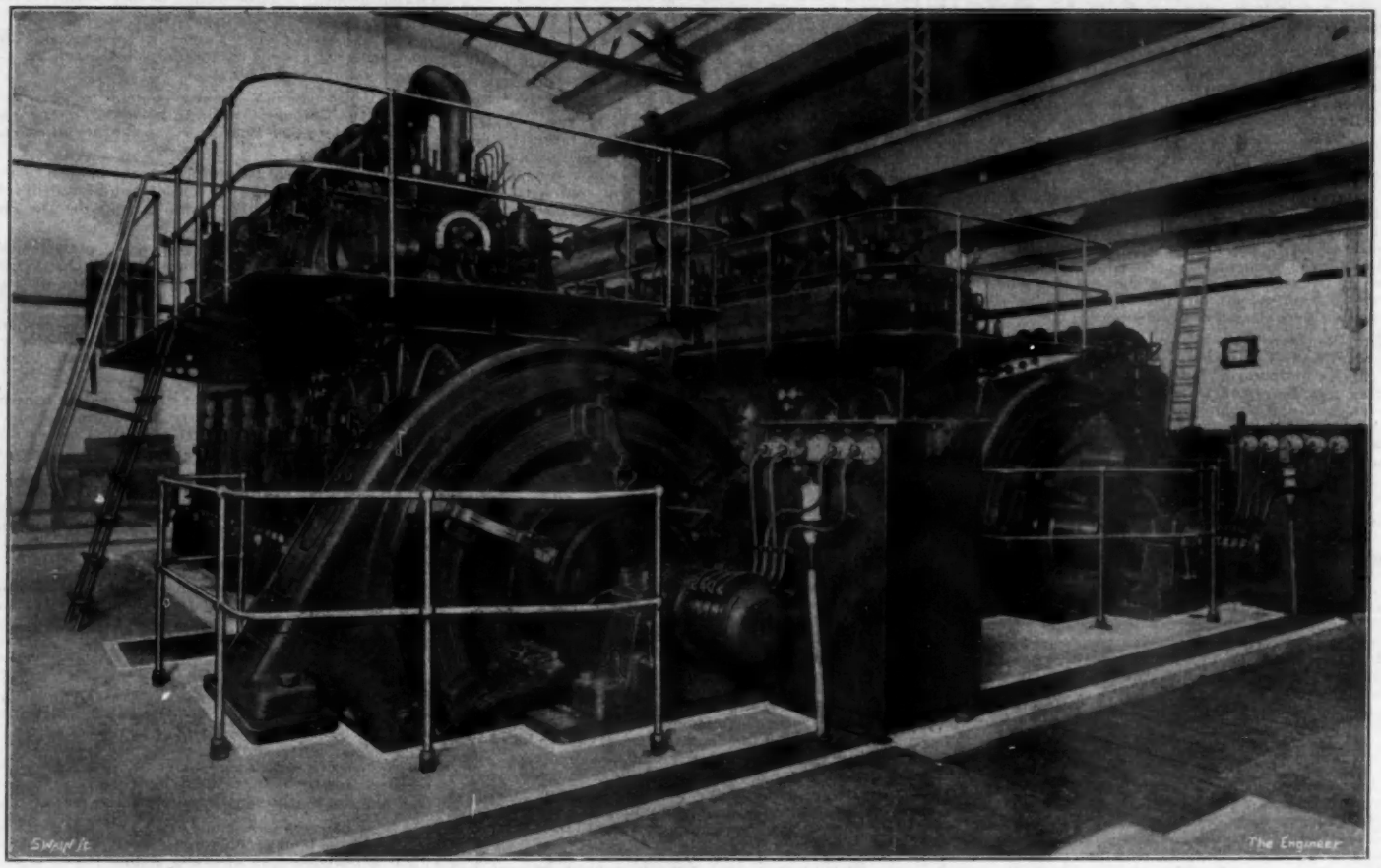


FIG. 6—TWO 400-kW D.C. OIL ENGINE GENERATING SETS

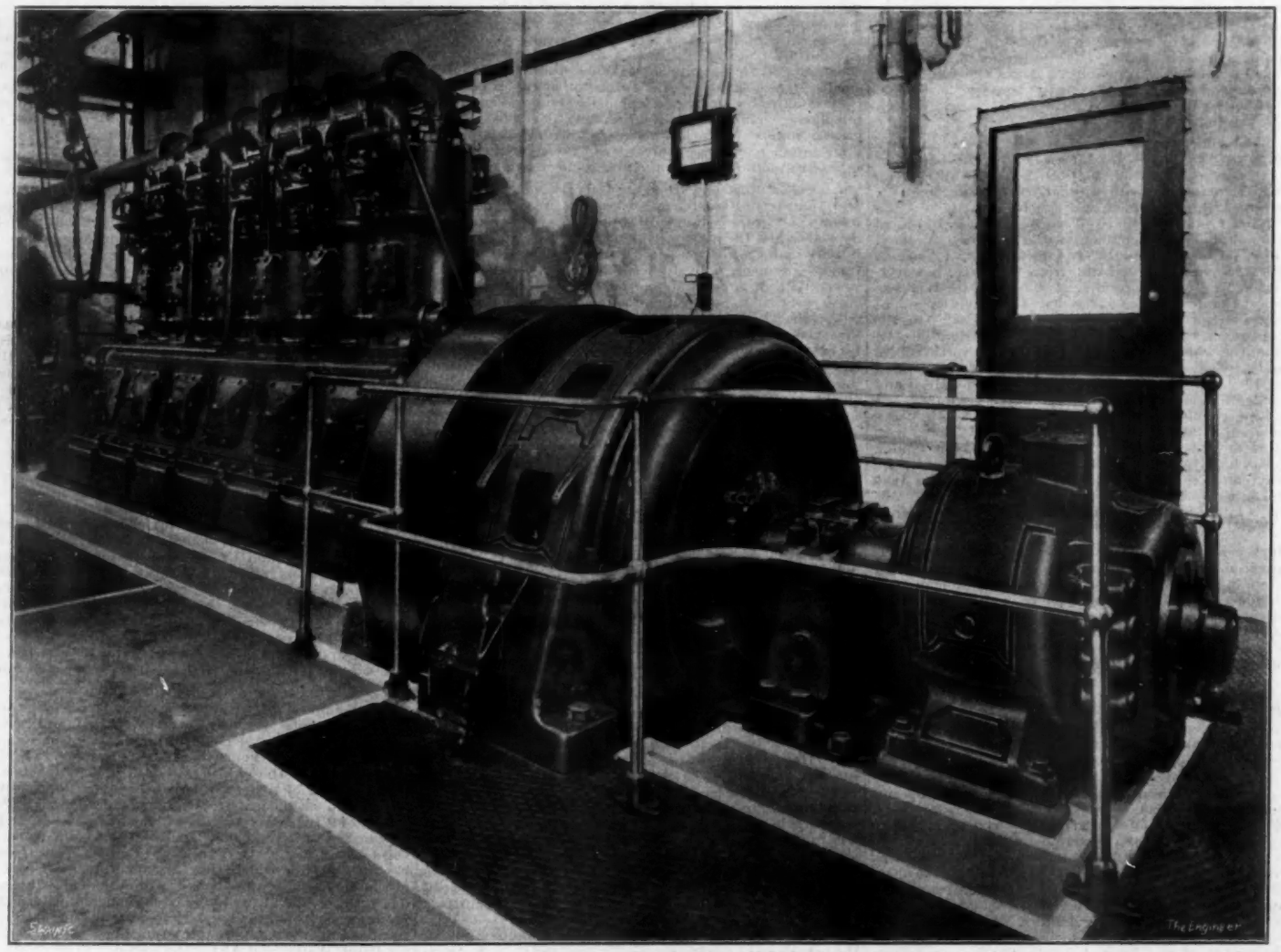


FIG. 7—150-kW A.C. OIL ENGINE GENERATING SET

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JANUARY 29, 1932.

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SIXTEEN-PAGE SUPPLEMENT—"THE METALLURGIST."

The Metallurgist.

THE JANUARY NUMBER OF THE MONTHLY METALLURGICAL SUPPLEMENT TO "THE ENGINEER" ACCOMPANIES THIS ISSUE.

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PAST AND PRESENT.

ONE by one the engineers who founded the famous Victorian firms are being gathered to their fathers. To-day we lament the loss of one of the greatest amongst them. With his more than seventy years' association with industry, Sir Alfred Yarrow's life linked the almost forgotten past with the present. He was a youth when Tyndall and Faraday were lecturing on science and when Colburn and John Bourne were writing on engineering. He knew the London of Dickens, and witnessed the decline of shipbuilding, from its once high estate, upon London River. The firm with which he was apprenticed, Ravenhill's, once well known on the Thames, has long since disappeared with Maudslay's, Samuda's, Humphrey and Tennant's, John Penn's and others, which were making the history of British marine engineering when Yarrow was still a boy. The description of his first works has a Dickensian savour. Two old cottages and a few broken-down sheds, the relics of a bankrupt, in the Isle of Dogs, on a bank, the "Folly Wall," which kept back the muddy Thames; and by it the "Folly" public-house, where Charles II. visited Nell Gwynne. There we have a contrast of squalor and romance which belongs to another age than ours and gives us a scale by which to span the seventy years since Yarrow, then but two years out of his apprenticeship, founded a firm which was destined to be famed throughout the world.

When we reflect upon the careers of many of the great engineers of the past who took upon themselves the responsibilities of works ownership when they were sometimes but little more, sometimes even less, than of age, we are led to ask if such things could be to-day. Given a youth with all the qualities of young Yarrow or Alfred Krupp, would the conditions of the twentieth century permit him to do what they did? Would he be able to start a factory with a few hundred pounds and build it up to great proportions, or would his solitary efforts be nullified by the lack of costly modern equipment, or be defeated by some powerful rival? Does not the ever-growing tendency to manufacture everything on the large scale destroy the chances of the daring individual? The answers to these questions are probably in the affirmative, but there is, to-day, a still more certain force at work to check the young pioneer. It is education. Yarrow was 'prenticed at fifteen, when boys of to-day are still at school. He was an owner at an age when our youths have not completed their technical education, and he was a successful shipbuilder at an age when they are seeking for a junior post in some great corporation. Of the advantages which our young engineers enjoy Yarrow and his contemporaries knew little or nothing. There were few facilities for scientific education and the nursing of apprentices was unknown. They had to rely upon themselves, snatching now and then the opportunity to hear lectures, or picking up what they could from the journeymen in the shops. It was not an age in which mediocrity was catered for; the best men succeeded on their own merits, the worse went to the wall. In these very different times one cannot help looking back upon those with respect and even wonder. If all that we do now is necessary, how is it that they, with so much less, made a so great success? The answer would seem to be that school and college are not nearly so important as individual power and courage. We have been gradually brought to believe that without a full education nothing can be achieved, and despite the evidence of the past, we have so hedged progress about with education that no man without it has an opportunity to make a start in his elected career. We say "no man," but that is not true; we were thinking of those who aim at executive posts in large firms. We had forgotten for the moment that in the greater industrial centres one may find little workshops started, not by men with a college training, but by workmen who have had the courage to strike out on their own. Most of them fail to get far, but we can recall several who have risen to positions of some importance. Who knows but that in some of these little works there may even now be men with the firmness of character, courage and stability of purpose that inspired the great, uneducated engineers of the past and brought them riches and renown.

The past is past. We can never go back again to the methods of the times when Yarrow was a boy. Democracy, which is the cult of mediocrity, has swept them away for ever. They were brutal times perhaps. They had no sympathy with the weak; they did not seek to give equal opportunity to all. Those who wanted opportunity had to find it and fight to keep it. Only the best succeeded. It is of them we read in the pages of history; what happened to the others no one knows. Now we try, by a complex educational system, to make a far greater proportion fairly efficient. No other plan is thinkable in this century. But whilst we are nurturing a mediocrity are we hampering the rise of great individuals? That is a vital question. It is frequently said by employers that they cannot find young men with the courage to take responsibilities and the personality to push them to success. High education, high scholastic qualifications are not lacking; they can be bought for a small sum. But the qualities that cannot be taught in classes are hard to find. In America, as in this country, we have been told the same thing. Sometimes we have suspected that the complaint is that of age for youth, but when we cast our eyes back to the wonderful courage and enterprise of the pioneers of our industry we wonder if, for all that we have gained by our more generous principles, we have not lost something that those far off harder days alone could give.

Agricultural Engineering.

THE construction of machines for cultivating and harvesting purposes was formerly an essentially British industry. It was the English who introduced machines on the Continent and laid the foundation of the industry there, and monopolised most of the trade down to the early years of the present century. Now, English makers are practically eliminated from Continental markets. In Germany, France and elsewhere war factories were turned over to the manufacture of agricultural machinery after the Armistice, because that class of productions seemed to offer the only possibilities of business. And the industry has grown so considerably under fostering influences that British makers, who are loaded with higher charges and shut out by foreign tariffs, see the end of their former supremacy. They have succumbed to what foreign buyers regarded as excessive prices. Successive shows of agricultural machinery in Paris have indicated a rapid elimination of the British effort to maintain Continental connection against adverse conditions. They have also shown new developments in agricultural engineering abroad, and at the exhibition held in Paris last week it was seen that there is a widening divergence between the British and German ideas of machinery design and construction. Apart from harvesting machinery, which is hardly capable of change, the German industry tends to develop in a direction entirely opposed to that of the British, and its new technical ideas are spreading all over Europe. This is obviously the result of the necessity which German manufacturers feel to impress upon buyers the value of improvements and of their natural inclination to effect such improvements by what the English maker would regard as an unnecessary addition of mechanical details. The English manufacturer has built up his machines out of long experience and knows the value of extreme simplicity, while the German tackles the problem without preconceived ideas. The English devised the straw trusser, which is ingenious and simple, and gives absolutely reliable service; the German complicates it to give denser trusses and avoid vibration, and makes it work with the silence of a precision machine. These improvements impressed the foreign buyer, who, though he has never had trouble with the English straw trusser, nevertheless believes that there may be something in these alleged improvements. English makers are fully alive to these German tendencies, which are influencing the whole of the Continent, and there has arisen a definite opposition between the two methods, which may eventually turn to the advantage of the English manufacturer, but will, almost certainly, result in new Continental developments which English makers cannot afford to ignore.

The Show of agricultural machinery in Paris emphasised the character of the prevailing depression, and there are economists even who point to the remarkable progress of mechanical products as a contributory cause of the low prices which have helped to upset the world's trade balance. But, whatever may be the effect upon the world's economic situation of the enormous production of grain with the aid of tractors and combined harvester-thrashers, it is clear that farmers cannot go back to old methods involving labour that can be avoided by the use of machinery. Those who are protected against the ruinously low level of world prices for wheat are caught by the relentless gears of machinery because they must get down their own prices to a point at which they can keep out foreign produce, even under the cover of import duties and quotas. A too big margin of price would make such protection valueless. The agricultural engineer has, therefore, a greater and more difficult problem to solve than has ever confronted him. It is easy to convert agriculture into a mechanical industry on the huge farms in America, Russia, and North Africa, but it is far more complicated to supply the small farmer with what is necessary to dispense with labour. Socially, that is undesirable; but economically there is no alternative, under present conditions, to the small agriculturist using power machinery or being driven out of business by an unwieldy world production. For some years past there has existed at Lausanne an international committee of experts which has exerted its efforts, so far with little success, to encourage agricultural engineers to produce universal types of motor machines for small holders. Engineers are working out the problem in their own way, and at the Paris Show one of the features was the large number of grass mowers fitted with oil engines for driving the cutter bar or for propelling the machine. For the moment, there seems to be an advantage for the small farmer to employ a horse-drawn grass mower with an auxiliary engine to actuate the cutter bar. The engine does not exceed 2½ horse-power, and it will drive a longer cutter bar and yet enable the horse to work comfortably the whole day. As these machines are employed only on a few days out of the whole year, it follows that the engine must be available for other power purposes on the farm. There are now some French makers of engines who are turning out small power equipments which are adaptable to all grass mowers and even binders. Trials in France have shown that the use of these machines allows of notable

economies in grass cutting. Motor ploughs have been less successful, because the general tractor is finding an increased utility on medium-size farms. The Paris Show makes it clear that the application of oil engines to agricultural machinery will continue to develop as the light high-speed, solid-injection engine improves, and will influence notably the future of agricultural engineering.

On account of the fall of the pound sterling, it was expected that British makers would have had an excellent chance to recover some of their lost ground on the Continent; but that advantage has been practically eliminated in France by the super-tax, and in any case the opportunities for business in agricultural machinery are at present restricted. Several English firms were represented at the Show, but they were considerably outnumbered by the German. The competition with German machinery is keen because the seller of an English thrasher or oil engine always knows that his price may be cut, and there will never be any stability in the Continental trade until it is organised on lines similar to those of other industries. The English maker has a valuable asset in the reputation he has always enjoyed from the time when he, almost alone, supplied the Continental markets, and he has no necessity to compete in "sensational improvements" which interest the farmer, without always influencing his conservative mind. For example, one English manufacturer presented a new and improved grass mower, and found that his French customers would not relinquish the old models of the same make, which had always given them satisfaction. Competition in standard implements and machines will become keener as time goes on, particularly if German firms succeed in their efforts to associate themselves with certain French makers who are now in difficulties, but there will always be an opening for English makers who get a close grip on foreign requirements and learn to know foreign customers as intimately as they do those of their own country.

Literature.

The Problem of Fluctuating Loads on Boilers. By G. E. HIDER, A.M. Inst. C.E., M.I. Mech. E., London: C. Griffin and Co., Ltd. 1931. 7s. 6d.

WHAT the fly-wheel is to an engine, a thermal storage system is to a boiler. Mr. Hider's book describes thermal storage, but it is concerned primarily with the effect of storage upon the economy of steam generation, and with the characteristics of types of boiler which govern the extent to which thermal storage is called for.

The author shows very clearly how in boilers with a relatively small water content rapidly or suddenly varying loads inevitably involve a serious fall of pressure as the demand increases, and this, in turn, reduces the efficiency of the steam-using plant; whilst when the demand for steam falls, the pressure rises until steam is lost by blowing off at the safety valves. Further, the combustion of the fuel cannot be maintained at maximum efficiency while the stokehold staff is trying to adjust the fuel and air supply to changes, the occurrence of which is only revealed when it is too late to cope with them adequately.

The two principal thermal storage systems—the "variable pressure" system, of which the Ruths accumulator, and the "constant pressure" system, of which the Kiesselbach accumulator are the outstanding examples—are then explained, discussed, and contrasted. Reference is made to the early work of Druitt Halpin in thermal storage, and to the Rateau type of steam accumulator—which, however, has no direct relation to the boiler load problem—and in an appendix an account is given of a feed-water thermal storage system recently developed on the Continent by Dr. Marguerre.

One could wish that the constructional details and control systems of steam accumulators were also described, as information on these interesting matters is not to be found in book form in English. They are, however, outside the theme of the book, in which the attention is focussed on the problem of the boiler plant in relation to fluctuating loads. Mr. Hider has performed his task well. The problem is clearly stated, the relationship of the boiler to the storage system, and of both to the variations in steam demand, are lucidly described.

The "constant pressure" and the "variable pressure" systems are compared in an interesting chapter.

In the latter type, during times when the demand is below the production rate, the surplus steam is condensed in the water contained in the accumulator, the temperature and the pressure in which rise. When the demand for steam exceeds the rate of steam generation in the boiler the pressure falls. The temperature in the stored water also falls and part of the water evaporates at the lower pressure, obtaining the necessary latent heat of evaporation from the heat given up by the water. The steam so formed supplies the extra demand.

In the "constant pressure" system, the accumulator is in continuous communication with the boiler, a pump maintaining the circulation of water between them, and an equalising pipe connecting their steam spaces. Assuming the accumulator to be "charged," *i.e.*, its contents at saturation temperature, if a demand for steam at higher than normal rate occurs, the consequent slight drop of pressure is utilised to control the feed pump, slowing it down or even stopping it. The steam is now generated from water already at saturation temperature, so that for each pound of steam required the generating plant has to supply only the latent heat. In comparison with generating steam from water at a lower temperature, when the water has to be heated as well as evaporated, the steam output for the same constant rate of firing is greater and thus peak demands, within limits, can be met. When the demand falls, the feed pump runs faster again and the accumulator is recharged.

For process work at pressures below that of the boiler, the range of pressure difference can be used for storage on the "variable pressure" system. For power generation, it is desirable to use the steam in the prime mover with a minimum drop of pressure from that of the boiler. This, other things being equal, favours the "constant pressure" system, which, on the whole, Mr. Hider appears to prefer.

There is an important factor, however, governing the maximum rate of steaming with the "constant pressure" type, which, while it is not ignored by Mr. Hider, requires more emphasis. It is the fact that the rate of discharge at constant pressure depends upon the temperature of the feed water entering the boiler, and if this temperature is high the discharge rate of this type of accumulator is limited. For example, at 200 lb. per square inch gauge pressure, the latent heat of evaporation is 838·5 B.Th.U., and the heat to generate steam from feed at 200 deg. Fah. is 1031 B.Th.U., while from 270 deg. Fah. it is 961 B.Th.U. Thus if the feed is at 200 deg. Fah., the ratio of the maximum rate of steaming with the aid of the "constant pressure" accumulator to the average rate is 1031 : 838·5, or the peak rate is 23 per cent. above the normal. If, however, the feed is at 270 deg., the above ratio becomes 961 : 838·5, corresponding to a peak of only 14·5 per cent.

The high feed temperatures resulting from modern methods of feed heating by efficient economisers or the like, and by exhaust or bled steam, or a combination of these, thus limit the peak loads that can be met by "constant pressure" storage of the Kiesselbach type.

The maximum steaming rate cannot be increased by adding to the capacity of the accumulator; it is a function of the steam pressure and the feed temperature only. With the "variable pressure" accumulator, on the other hand, as pressure falls to the lower limit the heat of the water is utilised in steam generation at a rate which is only limited by the area of the water surface from which the steam can escape. In fact, in the Ruths accumulator the steam discharged has to pass through a safety nozzle, the function of which is to prevent the discharge attaining an undesirably high rate.

In short, the constant pressure type can deliver its stored steam at rates up to a maximum fixed by the feed temperature. The Ruths type can deliver, if necessary, at a much higher rate, though for a corresponding decreased duration.

If, however, in a plant provided with a "constant pressure" type accumulator, the boiler pressure is allowed to vary, then, of course, the discharge rate can rise, and, as Mr. Hider points out, the "constant pressure" accumulator can act according to both systems in combination, though constancy of pressure is then sacrificed.

A chapter on thermal storage in conjunction with waste heat boilers should be of special interest to steel works engineers.

The reaction of thermal storage upon the choice of boiler types is well brought out by Mr. Hider, who shows that while the large water content of shell type boilers is advantageous, the addition of a storage system to water tube boilers overcomes their inherent lack in this respect.

The book will interest all and repay study by all concerned with boiler economics.

Jane's "All the World's Aircraft, 1931." Edited by C. G. GREY. Compiled by LEONARD BRIDGMAN. London: Sampson Low, Marston and Co., Ltd. Price £2 2s. net.

IT says much for the growth of aeronautics that in this, the twenty-first issue of Jane's well-known aircraft reference work, over 600 large-sized and closely packed pages are required to present an adequate record of the world's current aeronautical activities. There is little or no "padding" in the book. Descriptions of machines and engines have been kept down to the minimum consistent with interest and utility, and there is no inclusion of any material that is out of date. In the first and second parts, somewhat inappropriately described as historical, we are given information concerning the civil and service aviation organisations and achievements of the different aeronautical countries. The third and principal section describes and illustrates the world's aeroplanes, civil and service, so far as official restrictions on the publication of information permit. In a comparatively short section the world's aero-engines are dealt with in a similar manner, while in the last, extending to not more than 10 pages, it has been found possible to say all that need be said concerning the world's airships.

Those who study the pages of this work will, we believe, not fail to be impressed with the evidence which it affords of the prominent position now occupied in the world of aeronautics by British manufacturers. That remark applies whether we are considering aircraft or aero-engines. There are now eleven firms in this country engaged in the manufacture of aero-engines. It is true that there are twelve in France and eighteen in the United States, but for variety of production British builders take the lead. One British manufacturer produces ten and another fifteen different sizes and types of aero-engine, and all are of well-tried and proved design. The same story is told in the pages of the work devoted to aircraft. There are now twenty-seven different British firms engaged in the manufacture of aeroplanes, and for variety of production the British pages are not surpassed by those devoted to the work of any other country.

The great and growing interest in aeronautics renders a work of reference such as Jane's "All the World's Aircraft," an essential companion to many people, and a useful and interesting volume to a host of others. This year's issue maintains the reputation for thoroughness and for the authoritative nature of its contents which has distinguished its forerunners. The volume may to some appear a little costly, but for the amount of information packed within its pages it is remarkably cheap.

Practical Cost Accounts. By ANDREW MILLER. Gee and Co. (Publishers), Ltd., Kirby-street, London. 1931. Price 8s. 6d. net.

"THE position of the cost accountant is now one of primary importance in every industry," is the considered opinion of Lord Weir, as expressed in a foreword to this little work, in which Mr. Miller is concerned with the fact that in the world of commerce waste is a very real factor, which always represents serious loss. His advocacy of a good system of cost accounts is inspired by its immense importance in clearly indicating where the waste is to be found. Obviously the system selected must be chosen with due regard to the products of the works in which it is to be installed, and here "Practical Cost Accounts" will prove of distinct service.

In reading through the sixty-four pages which are comprised in this book we cannot fail to be struck by the amount of information compressed into it, but this very brevity, commendable though it is to those who have a knowledge of cost accountancy, will prove a definite drawback to an engineer who is approaching the subject for the first time. For example, we are convinced that from a perusal of these pages he could not appreciate the machine-hour rate method of recovering oncost, although he might be enabled to form a general idea of the underlying principles. From the engineer's standpoint we should like to have seen more stress laid on the value of reliable cost accounts to the estimator, not only in assisting him to build up his estimate, but also as a check on it when actual costs are determined. In dealing with the different methods of remunerating labour, although the author has clearly described premium bonus systems, he has not considered the collective systems and various profit-sharing schemes.

Altogether the author sets out his subject in a very succinct manner, and this little volume should prove really valuable to cost accountants and students, while giving engineers and manufacturers a very good general idea of the magnitude and diversity of the problems involved. The thirty forms, charts and diagrams which are neatly bound at the back can readily be opened out and consulted at the same time that the text is being read, and they should prove of great assistance to a clear conception of the subject.

BOOKS RECEIVED.

Motor Ship Reference Book for 1932. London: *The Motor Ship*, 5–15, Rosebery-avenue, E.C. 1. Price 5s. net.

The Confessions of a Capitalist. By E. J. P. Benn. London: Ernest Benn, Ltd., 154, Fleet-street, E.C. 4. Price 3s. 6d. net.

Production. By Hubert Phillips, M.A. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 5s. net.

The Supply of Water. By T. H. P. Veal, B.Sc., &c. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 15s. net.

The "Mechanical World" Electrical Pocket Book, 1932. London: Emmot and Co., Ltd., 65, King-street, Manchester. Price 1s. 6d. net.

Newton: The Man. By Lieut.-Col. R. de Villamil, R.Eng. (Ret.). London: Gordon D. Knox, 106, Guilford-street, W.C. 1. Price 3s. 6d. net.

Ice and Cold Storage Trades Directory and Reference Book for 1932. London: Iliffe and Sons, Ltd., Dorset House, Tudor-street, E.C. 4. Price 11s. net.

Practical Mathematics. By Louis Toft and A. D. D. McKay. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 16s. net.

Obituary.

SIR ALFRED F. YARROW.

ALFRED FERNANDEZ YARROW was born in London on January 13th, 1842. He had, therefore, reached the advanced age of ninety years at the time of his death on January 24th. His father, Mr. Edgar Yarrow, had married Esther Lindo, the daughter of his employer, a West India merchant and a Jew, and to his Jewish descent Sir Alfred frequently attributed the talents with which he was abundantly endowed. He was educated, first, at a small school at Holloway, then at a boarding school at Reigate, and finally at University College School. At the age of fifteen and a-half he was apprenticed with the firm of Messrs. Ravenhill,* whose business consisted almost entirely of the construction of marine engines for naval vessels. Whilst there, young Yarrow further extended his experience by spending his Saturday afternoons at the establishment of a jobbing smith, since the apprentices at Ravenhill's were not permitted to enter the smiths' shop. He also attended every scientific lecture for which tickets could be obtained, and in 1859, when in his eighteenth year, he, with a few others, founded a society—the Civil and Mechanical Engineers' Society—for the reading and discussion of papers on engineering and kindred subjects. The Society first met in Albert-square, Stepney, and later in Cheapside and at the Freemasons' Hall, with, at one time, the late Dr. Maw as its President.

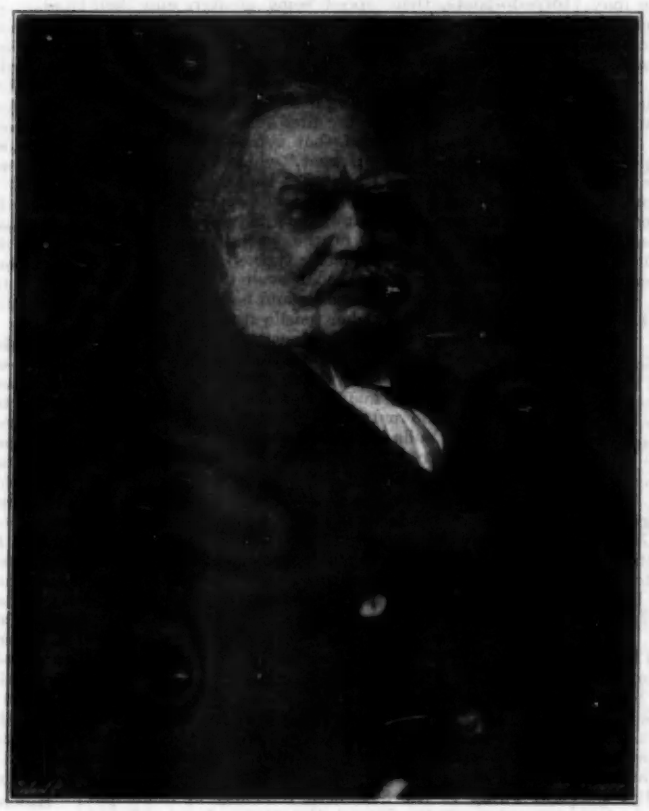
On the completion of his apprenticeship, Yarrow, who was then twenty-one years of age, naturally looked about for work. An offer made by Messrs. Ravenhill of a post in their drawing-office at a salary of £100 a year was refused. The young man was at the time receiving small sums in royalties, in payments for drawings and designs, in fees for inspections, &c., and his main ambition was to obtain sufficient capital to launch his inventions, about some of which we shall speak immediately, and to fit up and open a small works in which he could execute any orders that he might obtain. At a time when he did not know in which direction to look for the necessary financial assistance he quite unexpectedly received a present of £200 from a maiden aunt, Miss Amelia Yarrow, and a further contribution—even more unlooked for—of £200 from a coloured planter in the West Indies, who had been acquainted with his father in Jamaica, and who sent the present to help in starting the son in life. Mr. Ellis, the underwriter, whose lectures he had attended, also unexpectedly came forward with an offer of £1000, or, if that were not enough, £2000 to help to start the workshop. Although the last-named generous offer was not actually taken advantage of, it was most gratefully acknowledged, and it materially assisted in stimulating the young man's efforts.

About the same time, too, Messrs. Coleman, agricultural engineers, of Chelmsford, determined to take up the manufacture and sale of a steam plough which had been patented, between the years 1860 and 1862, by Yarrow in conjunction with Hilditch. The Colchester firm opened an office in London for the purpose of pushing the business and agreed to pay Yarrow a salary of £100 a year for looking after it. The royalties on the plough patent amounted in a few years to some £600, which the inventors divided between them. During the time that Yarrow was in charge of the office in London he added to his income by the preparation of working drawings for all kinds of machinery and by acting as inspecting engineer for commercial firms. He also had occasionally to give evidence in court on technical subjects. About that time, too, he, again in collaboration with Hilditch, designed and patented a steam carriage for use on ordinary roadways. The invention was taken up by a Mr. T. W. Cowan, of Greenwich, who agreed to pay a royalty on the vehicles constructed. One was built and plied between Greenwich and Bromley—a distance of 10 miles—once a week late in the evening for a short time. This steam carriage was shown at the International Exhibition of 1862, where it attracted a good deal of attention. It did not, however, receive any award for the somewhat peculiar reason that, though the jury deputed to deal with engines considered the exhibit to be a carriage, the jury which had to do with carriages regarded it as an engine! The vehicle therefore fell between two stools, though both juries wrote to Yarrow and Hilditch stating that they had closely inspected the carriage and that if it had come within their range they would certainly have made an award in its favour. That, however, was but cold comfort, and, on the whole, the attempt to introduce self-propelled steam vehicles on common roadways may be looked upon as among Yarrow's few failures.

At the end of two years in charge of Coleman's London office, Yarrow found himself in possession of a capital of about £1000, and he felt that the time had come when he could safely set up in business for himself. For this purpose he entered into partnership with a Mr. Hedley, whom, he hoped, would have influence in obtaining orders to repair river steamboats. Mr. Hedley had no capital in the concern. A small works on the Folly Wall, in the Isle of Dogs, consisting of a couple of old cottages and a few broken-down sheds, was acquired. A few shipbuilding tools, which had been the property of a former tenant, were rented with the place and put in working order and a small machine shop was built. For the first year or so only a few small orders were booked. The work undertaken was of a most varied character. So far from its being entirely confined to the repair of river craft, as had been intended, it comprised such diverse things as the construction of a thief-proof door to a safe in a jeweller's shop at Brighton; the fitting of an iron crane-chain-fending roller over a doorway in Southwark; the making and fitting of some overhead travelling pans in a sugar factory; an apparatus for roasting coffee; some match-making machinery; the repair of a boiler in a jam factory, &c. That first year was a period of great anxiety. During it, and for some time thereafter, Yarrow himself made all the drawings, kept the books, paid the wages, and looked about for orders while Hedley's business was to see to the carrying out of the work.

The second year was even more unprofitable than the first. With the object of extending the scope of their operations, the two members of the firm endeavoured to secure work on a larger scale. The result was disastrous, for at the end of the year their books showed a deficit of £2000. At that period Yarrow's father wanted him to give in and go through the Bankruptcy Court, but his mother, who had unbounded faith in him, encouraged him to go on and he complied with her wishes.

As a matter of fact, the time was a turning point in the firm's career. While still at Ravenhill's, Yarrow and Hilditch had built a small steam launch called the "Isis," which had proved a source of great enjoyment to the two lads, and, when seeking about in every direction to find something which might result in profit, Yarrow—at the time when his fortune seemed at the lowest ebb—suddenly had the idea that the building of small steam launches for use on the river might be successful financially. He accordingly inserted an advertisement in the papers, and three days afterwards received an order from a Colonel Halpin for a 24ft. steam launch with a cabin to accommodate four passengers. The price was to be £145, and the boat, which took three months to build, actually cost £200. However, the little craft was a great success. At the end of the summer, Yarrow bought her back for £100 and sold her the same day for £200. At the end of the next summer he again purchased her for £100 and sold her for £300 to a Russian who took her to St. Petersburg. Thus, although the boat was built at a loss, the firm did very well out of her after all. In fact, if the original loss had not been made good, her construction would have been well worth the while, for she proved to be the basis on which was erected one of the most extensive and noteworthy businesses concerned with the design and building of fast steamships of all types—particularly torpedo craft and vessels for pioneer and general navigation on shallow rivers—that the world has known. For seven years after the first launch was turned out the building of similar craft was continued without a pause, and the initial mistake of underestimating the cost of construction was not again made. Up to the end of 1875 no fewer than 350 steam launches, their prices varying from £140 to £2000, were built.



SIR ALFRED YARROW

Just prior to his first marriage in 1875 it had become evident to Yarrow that his partnership with Hedley did not work as smoothly as he could have wished, and the partnership was dissolved, Hedley drawing out of the business a large sum of money on condition that he would not enter into active competition with his former partner. Incidentally, it may be recorded that Hedley did not fulfil his part of the bargain. He bought a yard about a quarter of a mile away from the establishment on Folly Wall and started a small business on his own account. It failed, however, and he lost all his money. Yarrow's business, on the contrary, continued to thrive, and he soon got together a small but thoroughly reliable staff, so that the loss of his partner rapidly ceased to be felt.

In addition to steam launches for river and similar navigation, the building of special craft for particular services was undertaken. Among the first of them was the "Ilala," designed for plying on Lake Nyassa and among the sand-banks and rocks of the Zambesi, for use in the suppression of the slave trade in East Africa. It was necessary that the vessel should be seaworthy and capable of steaming against a swift current and that she should be built up of light sections which could be disconnected at will and carried many miles through forests when rapids were encountered. The little boat was a great success and was followed by the "Pioneer," the "Adventure," and the "Dove," which were ordered by the British Admiralty. The last-named was propelled by side paddle-wheels and only drew 8in. of water, and may be regarded as the ancestor of a long line of a variety of special vessels, particularly those for navigation on rivers abounding in shoals and rapids which were designed and built by Yarrow at various periods, some of which had stern wheels and some side wheels. Later, in 1883, he designed and built to the order of the King of the Belgians, who had acquired the services of Mr. Stanley to explore the Congo, a special vessel for that purpose. The boat was built up of sections, which were themselves floating and which, while afloat, could be joined together by bolts and nuts so as to form a complete vessel. To get over the difficulty of the sections tending to sink when water entered them through the bolt holes, a vertical plate, of such a height that even when the water got in it could not rise in the section above the level of the plate, was arranged parallel with and a short distance away from the bulkhead. The distance apart of the bulkhead and plate was sufficient to permit the hands of the men tightening the nuts to be inserted. As soon as the bolting up was finished the water was pumped from the space between the two plates. When it was desired to transport the sections over land, wheels were passed under and attached to each section while it was afloat, so that, actually, the sections were transformed into wagons which could be drawn along. "Le Congo," as the vessel was called, which was propelled by a stern wheel, was a great success, and as a consequence of the adoption of this method of construction a number of similar vessels were ordered from the firm.

At an earlier period of Yarrow's history—namely, in March, 1874—"Chinese Gordon," before pro-

* Ravenhill, Salkeld and Co., Glasshouse Fields, Ratcliffe, formerly Miller and Ravenhill, and previously Barnes and Miller. Ravenhills joined with Easton and Amos, who were famous for hydraulic machinery and centrifugal pumps.

ceeding on his first mission to Khartoum, asked him to call on him so that he might obtain the fullest particulars as to the type of vessel which might prove most useful on the Nile. In view of the prevalence of the masses of floating vegetation or "Sudds" in that river, Yarrow came to the conclusion that screw propulsion was out of the question, and decided to adopt a stern wheel, and he got out a design of boat which could be shipped in sections, each of which was light enough to be carried on a camel's back. Nothing further was heard of the matter for many months, and then the Governor of the Equatorial Provinces was commissioned by Gordon to order from Yarrow four steamers which should be built to the designs submitted at the interview above recorded. The vessels were made, sent out to Khartoum, and put together on the banks of the Nile. They were subsequently used in the defence of Khartoum and were sent down the Nile to meet the relief expedition under Lord Wolseley.

Mention may here be made, too, of the "hinged-flap" method of screw propulsion, which was adapted by Yarrow successfully to certain shallow-draught river steamers intended to operate under special conditions of navigation. Among the vessels which were designed and constructed by him to work on that method were the two gunboats "Sultan" and "Sheik," which were used by Lord Kitchener in 1897 in the recapture of Khartoum.

It would be impossible in such a memoir as the present to refer to every one of the other numerous and varied craft which were designed and constructed by Yarrow during his long career. Reference may, however, be made to the stern-wheeler which was built for the King of Burma in 1876; to the early battery-operated electric launch which was built in collaboration with Messrs. Siemens in 1883; to the stern-wheeler which was built for service on the Alto Uruguay River; to the shallow-draught gunboats "Mosquito" and "Herald" built for service on the Zambesi, which were delivered in the short space of twenty-five days from the receipt of the order; and to the shallow-draught stern-wheeler gunboat "Opale," ordered by the French Government for service in Dahomey. As a change from steam propulsion it may be recorded that a small yacht built by Yarrow and driven by internal combustion engines figured prominently on the Solent during Cowes Week in August, 1906. This little vessel had a flat bottom and developed a high speed of travel.

The types of high-speed vessels with which the name of Yarrow is more particularly identified by the general public, however, are torpedo-boats and destroyers—to give them their shortened title. The firm's connection with torpedoes began in the year 1873, when Yarrow mounted a torpedo spar on one of his fast launches. The first launches specially designed by him to carry torpedoes were ordered by the Argentine Government. They measured 55ft. in length and were followed by one of 75ft. for the Dutch Government. That was the beginning, and during the two years 1877 and 1879 orders were received for torpedo craft from the Argentine, Austrian, Chilian, Dutch, French, Greek, Italian, Russian, and Spanish Governments.

The first Yarrow torpedo-boat to be ordered by the British Government was known as the "Admiralty Sample Boat." She was frankly regarded by the authorities as, to a certain extent, an experiment. A similar order was given to any firm which was considered to possess a reasonable prospect of carrying out the work successfully. Each firm had to guarantee under penalty a speed of 18 knots. Actually, the Yarrow boat attained a speed of 21·9 knots, which is said to have been 3 knots in excess of the highest speed attained by any competitive vessel tested under the same conditions. Yarrow was always persuaded of the great importance attaching to research and experiment, and the abnormal speed reached by the vessel is reported to have been mainly due to some interesting experiments which were carried out by the firm in connection with propellers. Up to that time, it had been generally believed that, for boats of the type, a propeller 5ft. 6in. in diameter, with narrow blades, gave the highest efficiency. It was also thought that, within a certain limit, the larger the propeller and the greater the area of water acted upon, the less would be the slip and the better the result. Acting on this supposition, Yarrow tried fitting a propeller 6ft. 6in. in diameter, with the unexpected result that only a considerably reduced speed could be reached. That discovery led to the carrying out of an extensive series of tests with twenty-five propellers of different diameters, pitches and areas and with two and three blades. As the outcome of these investigations a propeller only 4ft. 4in. in diameter and with three blades was found to operate most efficiently, the speed attained being greatly enhanced as compared with that reached by the larger propeller, in spite of the fact that the slip was increased.

In 1877 the Russian Government ordered two torpedo boats from Messrs. Yarrow, but, in consequence of the outbreak of the Russo-Turkish War, these vessels were not allowed to leave this country and were acquired by the British Admiralty. The terms of payment stipulated for a heavy penalty if a speed of 18 knots were not reached. Yarrow agreed, on the condition that a similar premium was granted for anything above that speed being achieved. Actually, the two vessels made 20·8 and 20·6 knots respectively, and the Admiralty had to pay £1900 in excess of the price at which the two boats were offered to it, and which at the time it had declared excessive. These two boats figured at a review of the Fleet held in the Solent in 1878, when they created a good deal of sensation. Commenting on the matter at the time, *The Times* remarked: "One of the features of the Review was the performance of two long, double-funnel torpedo-boats built by Yarrow, which have realised the extraordinary speed of 21 knots. The manner in which these malevolent-looking craft rushed up and down the lines and round the ships was the astonishment of all beholders."

These two little vessels, which the late Queen Victoria, who had seen them operate, declared had interested her more than anything else at the Review, were instrumental in first bringing Yarrow's name prominently before the public.

Just previously, one hundred torpedo-boats had been built in Russia to Yarrow's designs. They were fitted with locomotive boilers using forced draught. In the spring of 1892 Yarrow, having paid a visit to some of the French shipyards, where he had seen some exceptionally fast torpedo-boats under construction, called at the British Admiralty to lay certain facts before Admiral Sir John Fisher, and to offer to build boats which would be superior to those of the French. He was asked to make a report on the subject, and as a result suggested the construction of boats 180ft. long by 18ft. beam and having engines of 4000 H.P. The new craft were to be designated "Destroyers," their office being to chase and destroy torpedo-boats, their speed being greater, and their armament heavier. Two vessels of this type were ordered—the "Havock" and the "Hornet"—and they reached speeds on official trial of 26·1 and 27·3 knots respectively. The higher speed of the "Hornet" was attributed to her being fitted with Yarrow water-tube boilers, she being the first vessel in the British Navy to have boilers of that type. The fact that, for a given speed, the "Hornet," which had a displacement of 11 tons less than the "Havock"—owing to the less weight of her boilers—had a coal consumption 5 per cent. less than that of the "Havock," indicated the superior efficiency of the water-tube boiler as compared with the locomotive type.

Yarrow was confident that even the high speeds reached by these two vessels could be improved upon if only material of a higher tensile strength than mild steel were to be used in the construction of the hull. He accordingly obtained from the Russian Government an order to build a vessel—to be known as the "Sokol"—which he guaranteed should reach a speed of 30 knots. The material which he used for the hull was called "Yolla" metal—a nickel steel—which had a tensile strength of 35 tons per square inch, as compared with the 28 tons of mild steel.

Yarrow began his investigations into water-tube boilers in 1877, but it was ten years later before he put one of his boilers in a torpedo-boat, and another five years went by before, as we have seen, there was a Yarrow boiler in the British Navy. The Yarrow boiler proved to be a great success and it was soon adopted by the navies of several countries.

Thirty years or more ago Yarrow began seriously to consider the transfer of his works on the Thames to some other locality. Economic conditions in the Metropolis were making it increasingly difficult to carry on business there. He felt, however, that it would be a severe wrench to tear himself away from a spot which he had occupied for so long, and from works which he had seen grow from quite small beginnings. But owing to the Socialistic tendency of municipal government in the district, the rates and cost of living in the Isle of Dogs were continually rising. Consequently, apart from the direct expenses in connection with the works, the rates of wages were higher than those paid for equally efficient labour in the provinces. Hence it was ultimately decided to transfer the works "lock, stock and barrel" to the Clyde. The removal was carried out with characteristic vigour and celerity. Between 4000 and 5000 tons had to be transported, including the most delicate models and the heaviest machine tools. Everything went by rail. Shipbuilding was started on the Clyde within a few months of turning the first sod, and, concurrently, the construction of machinery was carried on at Poplar until the last moment. The feu contract for the Scotstoun yard was signed on February 24th, 1906, and the first destroyer was launched on July 14th, 1908. The removal, which has been referred to as a stroke of genius, amply repaid by the results achieved the thought, labour and money spent upon it.

Towards the end of 1913, when he was seventy-two years of age, Yarrow left Scotland to reside in the South of England, and thus ceased to be in personal touch with the works. He continued, however, to retain control of the firm's operations, leaving his eldest son Harold in full charge. He considered it impossible completely to retire at a period when he felt so full of life and energy, and he determined to keep well informed as to everything that was going on by interchange of visits, by daily telephone conversations, and by written communications. He went on a journey through Canada with his second son Norman, which resulted in the founding of a branch establishment of the firm at Victoria, British Columbia, of which Mr. Norman Yarrow is in charge.

Then, in August of the following year, came the Great War, and Yarrow, with apparently renewed youth and vigour, plunged into all the work which was possible for him to do. No less than twenty-nine destroyers left the Scotstoun yard during the war period. Twenty-seven of them were for the British Navy, one for Japan, and one for Italy. Just before the outbreak of war, Yarrow had approached the then First Lord—Mr. Winston Churchill—and promised, if an order for three destroyers were given to him, that they should be improvements on the "Lurcher" class, and should be the fastest ships afloat. The order was given and the "Miranda," "Minos," and "Manly"—delivered after the war began, developed speeds of about two knots faster than those of the "Lurcher" type. Later the "Tyrian," which could steam 1000 knots without refuelling, very nearly reached 40 knots when fully equipped. In addition to the destroyers several other vessels of quite a different type were produced.

The construction of warships, however, by no means represented all that Sir Alfred did or devised during the war period. For example, he converted the Convalescent Home for Children at Broadstairs—about which we speak later—into a well-equipped military hospital; made several minor inventions of use to the Forces in the trenches; and undertook the manufacture of artificial limbs.

We have already referred to Sir Alfred's belief in research work, and a tangible example of his desire to assist it financially was the experimental tank at Bushey, which he gave the funds to build. He had often been puzzled by conflicting speed results, which were experienced with high-speed vessels carried out under, apparently, identical conditions. The variations in speed were for a long time unaccountable and mysterious, but Sir Alfred, being determined to get to the bottom of the matter, carried out a series of exhaustive experiments with a fast destroyer. The tests were made with the same vessel, the same crew, the same displacement, on the same day and at various speeds, so that, as far as possible, varying conditions, which might lead to discrepancies, might be eliminated. These trials led to results of exceptional value. It was found that the longitudinal inclination of a vessel with a given number of revolutions of her engine depended upon the depth of water under the hull, when running at a speed of 20 knots or over, and that fictitious speeds, in excess of the true speed in deep water, could be obtained if the water were shallow. At the same time, Sir Alfred had corresponding trials made with models—which amply confirmed the results obtained with a destroyer—but those trials had to be carried out by foreigners, since there was no tank available for making them in this country. He therefore determined to obtain for Great Britain an experimental tank which might be available for research work. He found, however, that the shipbuilders and shipowners would not sufficiently co-operate, and the necessary sum of money to build such a tank was not forthcoming. Deeming it hopeless to look for assistance from those directions or from the Government, he decided to finance the proposal himself and ultimately made to the Royal Society an offer to build a tank at an estimated cost of £20,000, provided that a similar amount, sufficient to cover the working expenses for ten years, was guaranteed. The offer was accepted and the National Physical Laboratory at Teddington was chosen as a suitable place for the tank, which was opened on July 5th, 1911, during the jubilee meetings of the Institution of Naval Architects in London. There is no need for us to lay stress on the enormous value of the results which have been achieved by its means.

Having during the course of his long and successful business career amassed a fortune of no inconsiderable magnitude, Sir Alfred set about, most generously, to distribute it during his lifetime, and no memoir, such as the present, would be complete without some reference to his munificence in this direction. In his benefactions he always bore in mind a saying of his friend, the late Canon Barnett, namely, that it was difficult to make money honestly, but far more difficult to spend it wisely. It would be impossible, of course, to put on record all the examples of generosity that he showed during his lifetime; some of them never became known, but some of them were world-famous. Every engineer, for example, has heard of the Convalescent Home for Children which he founded at Broadstairs. This Home, which was intended for the reception of some 100 children, the sons and daughters of educated people who might be unable to afford the full expense of a stay at the seaside, so necessary for recovery after illness or an operation, was endowed to the utmost limit that was deemed to be wise. Again, he gave to the London Hospital a sum of £25,000, on condition that a sufficient sum should be subscribed in addition to that amount to build and equip an out-patients' department—a condition which was realised, and the building was opened by the late King Edward in 1903. Further, the sum of £20,000 was in 1908 given by Sir Alfred to the same hospital to found a research fund. When the firm migrated to Scotland he gave £24,000 to be used partly in adding to the Nurses' Training Home at Govan and partly in grants for establishing such nurses in the isolated Highlands and islands of Scotland. He also financed and liberally endowed a Girls' School for Domestic Service at Chislehurst. After a visit to Girton College, Cambridge, he decided that a debt of £24,000, which had been incurred by that institution, must be paid off, and offered, anonymously,

that if £12,000 could be collected in three months to make up the balance. The sum was duly subscribed. He also gave a further £10,000 to the College to aid students in research work. A much larger gift was the £100,000 which Sir Alfred presented in 1923 to the Royal Society—of which he had been made Fellow in 1922—the income to be used for assistance to distinguished men engaged in research, so that their entire time might be available for their investigations. He also made a further gift to the Royal Society so that if any of his descendants, during a period of fifty years, were short of funds for education, the Society could, at its discretion, provide additional means. Finally, reference may be made to the £20,000 which he presented in 1926 to the British Association, the capital sum and the interest on it to be devoted to the advancement of science, a condition being that the amount should be exhausted by yearly payments spread over a period of twenty years.

In the foregoing brief summary of the life story of Sir Alfred Yarrow much has, of necessity, been omitted. It has been impossible, for instance, to review his feelings regarding education—especially the education of young engineers—which were of a clearly defined character, and in which he was by no means always in agreement with other educationalists. Nor has space permitted the giving an account of his feelings for and treatment of his employees, of his attitude during the engineers' strike of 1897, nor of the campaign to disseminate propaganda in neutral countries during the war. We have, we hope, however, said enough to give some idea of the general direction, taken by the numerous activities of this very remarkable man, in which he was engaged throughout the whole of a lifetime that was extended far beyond the usual limit. He was created a baronet in 1916.

It only remains to say that after the death of his first wife Sir Alfred married, in 1922, Miss Eleanor Barnes, the daughter of a life-long friend of his first wife. Lady Yarrow, who had for years acted as his confidential secretary, survives him. To her book, "Alfred Yarrow: His Life and Work" (Arnold), we are indebted for much of the information given in this memoir.

LOUIS BRENNAN.

As we briefly announced in our issue of the 22nd inst., Mr. Louis Brennan died at Montreux on January 20th. He was born in 1852 and, had he lived but a week longer, would have completed his eightieth year. He was a native of Castlebar, in Ireland, but when only nine years old or so was taken to Melbourne, where he continued to live until 1880. It was during that period that the idea of a self-propelling dirigible torpedo occurred to him, and it is with his torpedo that his name is most particularly identified by the general public, though, as a matter of fact, he was concerned, during a particularly busy life, with numerous other inventions.

The general principle on which the torpedo was operated was very simple. Inside the body were two reels, on which was wound steel wire of No. 18 gauge. The outer ends of the wire were connected to two drums driven by an engine—either on shore or on the vessel from which the torpedo was launched. The drums, which were 3ft. in diameter, had a peripheral speed of some 100ft. per second, and, as the wire was hauled in, it revolved the reels in the torpedo to which a very high speed of revolution was imparted. The reels, in their turn, revolved twin screws which propelled the torpedo, the screws operating in reverse directions. Contrary to what might have been expected, the "drag" brought about by the wires was so small as compared with the power utilised in spinning the reels, that it might be left out of calculation altogether.

The invention having been examined and tested by the Australian authorities, it was decided that it should be submitted to the British Government. Mr. Brennan accordingly visited this country and a careful investigation of the torpedo and its capabilities was made by a committee of experts. Eventually the Government decided to purchase the invention for a sum which was reported to be well over £100,000, and Mr. Brennan was granted the use of a casemate on the upper tier at Garrison Point Fort, Sheerness, in front of which there was sufficient sea room for carrying out preliminary trials. Tests, made under official inspection, were so satisfactory that, as we reported in May, 1885, the Admiralty agreed to adopt the torpedo as part of the national armament. A Government factory was established for the construction of the weapon, and of that factory Brennan acted as superintendent from 1887 to 1896. Thereafter, till 1907, he was consulting engineer to the establishment, and was therefore connected with it for a period of some twenty years.

Mr. Brennan, during his residence in Australia, had been struck by the difficulties and expense of building railways through hilly country or through sparsely populated lands which could not be expected to furnish traffic sufficient to furnish an adequate return on a heavy outlay, and he conceived the idea of a self-propelling vehicle, which would be capable of travelling on a single line of railway or even on a tightly stretched overhead cable. As soon as he had given up the post of superintendent of the torpedo factory—that is to say, in 1896—he began a series of experiments with the object of putting that idea into effect. His contention was that if such a conveyance could be satisfactorily constructed it would enable the cost of railways, particularly those along the sloping sides of mountains, to be much reduced as compared with that of those needing a pair of rails, and the ultimate cost of traction to be enormously lessened. In his mind's eye—as he himself testified—he envisaged "vehicles of colossal dimensions, more like moving hotels or shops on shore than the usual form of railway carriage, travelling at velocities of probably more than three times that attainable at present." In fact, he quite looked forward to constructing coaches 25ft. wide and, perhaps, 150ft. long. That was in the year 1907. To those advantages would be added, he claimed, complete absence of lateral oscillation in the carriages and a great increase in the smoothness with which they would run.

In our issues of May 10th, 1909, and November 12th, 1909, we described two vehicles which the inventor designed and built at Gillingham, in Kent, where he lived at the time. In the first, which was built to one-eighth the scale of a much larger vehicle on the production of which he was at the time engaged, the car resembled a pontoon or barge, part of its inside being arranged for passengers and part for goods. It was carried on two two-wheel bogies, one at each end, these bogies being so pivoted that they allowed the car to turn easily on curves, and also permitted vertical movement. It was claimed for it, in fact, that the carriage would run on curves of even less radius than its own length, or on crooked rails, or on rails laid on uneven ground without any fear of derailment. The pairs of wheels in each bogie were coupled, and one wheel in each set was driven direct through gearing by an electric motor carried on the bogie, the power for propulsion being obtained from a battery of secondary cells.

To maintain the car vertically in a state of equilibrium there were two heavy gyroscopic wheels made to revolve in opposite directions in a vertical plane and in a partial vacuum. These wheels were coupled together so that their peripheral velocities were the same, special means being provided for advancing the precession of the gyroscopes so as to cause them more quickly to return to their normal plane of rotation should there be a tendency for them to be diverted from it. The gyroscopes were motor driven at a speed of from 7000 to 8000 revolutions per minute. Under test, the car was loaded with weights representing 20 tons, and it travelled upright on a single rail under its own power. In order to prove its stability, a weight corresponding to that of fifteen men was suddenly thrown on its side, and it was noticeable that the side on which the weight had been thrown gradually rose until a position of equilibrium was reached. The vehicle easily climbed up a gradient of 1 in 5.

This car showed clearly that, by the aid of gyroscopes, it was possible to make an unstable body stable when the gyroscopes were in operation and to make a vehicle run on a single rail. The success achieved, in fact, was such that the War Office, the India Office, and the State of Cashmir came forward with pecuniary assistance which enabled Brennan to carry his invention to such a point that he was able to apply it to a vehicle capable of dealing with loads up to 15 tons and designed to work in actual service.

The second vehicle was built at the Brennan Torpedo Works at Gillingham, near Chatham. It was carried on four wheels mounted in two independent bogies, the two wheels in each bogie being coupled. The centre pins of the bogies were connected to the body of the vehicle by means of ball bearings so as to give flexibility in negotiating curves. One wheel of each bogie was driven by an electric motor through reduction gearing. The car-body was composed of a platform 10ft. wide carried on rolled joists, at one end of which was a cab containing the propelling and controlling mechanism. The former consisted of two petrol engines, one rated at 80 and the other at 20 H.P. Each engine drove, directly, an electric motor which supplied current (*a*) for driving the trolley motors and, hence, for propelling the car; (*b*) for revolving the wheels of the gyroscopes, of which there were two; (*c*) for compressing air for the brakes, &c.; and (*d*) for operating a small motor driving an oil pump.

The gist of the whole system lay, of course, in the gyroscopes, the duty of which was to correct any tendency of the vehicle to depart from a position of stable equilibrium. The two devices were mounted side by side, but some few feet apart, in the cab. The wheels of each weighed ¾ ton, and each was driven at a speed of 3000 r.p.m. by a shunt-wound motor. Each wheel and its motor were contained in an air-tight casing, and they were run in a vacuum, equivalent to a column of from ½in. to ⅝in. of mercury. As long as a vacuum of that character was maintained the motor ran quite cool, but as soon as air was admitted the motor ran hot. Incidentally, it may be remarked that Mr. Brennan, in view of that fact, suggested that much, at any rate, of the heating in electrical machinery was due to air friction.

The two gyroscopes were arranged with their axes horizontal, and normally at right angles to the rail. When there was a tendency for the vehicles to lean either to one side or the other, that tendency was corrected automatically by mechanism actuated by pneumatic power, which altered the planes of rotation of the gyroscopes, so that they were deflected either to the left or to the right in the vertical plane, as the case might be.

The total wheel base of the vehicle was 20ft., and that of each trolley or bogie 5ft. 4in. The total weight empty was 22 tons, and the load carried from 10 to 15 tons. On trial the vehicle easily negotiated some heavy curves, and, as built, it could mount a gradient of 1 in 13, though it was stated that, with some additional power, representing an added weight of some 4 tons, it could have climbed a gradient of 1 in 6½. The two engines, mentioned above, were put in so that the power applied could be varied from 20 to 100 H.P. With 20 H.P. a speed of 7 miles and with 100 H.P. 35 miles an hour could be attained. What the future of this mono-rail might have been under more favourable circumstances it is impossible to say. It had reached a very interesting stage, and there was reason for believing that a railway would be erected over a difficult district in India, but the war put an end to further development.

Another direction in which Mr. Brennan turned his energies was aeronautics. Towards the end of the War he succeeded in persuading the Government to grant him facilities for developing his ideas on helicopter flying machines. For five or six years work proceeded at the Government's expense on the construction of the Brennan helicopter at the Royal Aircraft Establishment, Farnborough. The outstanding feature of the design was that each arm of the helicopter "windmill" was provided with an engine and air screw at its tip. As an official machine, the Brennan helicopter was expressly excluded from taking part in the Government's helicopter competition in connection with which a sum of £50,000 in prizes was offered in May, 1923. Fifteen entries were received for that competition, but none of them resulted in the production of a machine. The competition was extended to April, 1926, but still no machines were submitted for trial. Meanwhile, work on the Brennan helicopter had proceeded so far that in October, 1925, the machine was taken out of its shed for a trial flight. It rose a foot or two off the ground, when it seemed to lose its stability. Toppling over, it crashed and damaged its structure to a considerable extent. Repairs were undertaken, but in the end the machine passed to the scrap heap.

We have mentioned the three inventions by which Louis Brennan is best known, but his fertile mechanical mind was never at rest, and he was the author of many other ingenious devices. One of them was an intriguing form of bioscope. The pictures were some few inches square, and were viewed through a lens. Movement was effected in this way. In front of the lens was a gridiron of narrow bars, with corresponding bars a few inches behind. A long strip of paper was wound continuous through the front and back bars, the bights on the former presenting an almost continuous surface. On this surface the pictures were drawn or photographed. By moving the paper a succession of pictures in slightly different attitudes was presented and the familiar effect was produced in the eye.

Louis Brennan was an Irishman of the Irish. He had all the charm of his race and was much beloved by all who knew him well. His ardour for invention never failed him, even when ill-health dogged him and drove him out of England during the winter months. He was a familiar figure in the Savage Club, of which the Bohemian atmosphere appealed to his temperament, and will be much missed by his "brothers."

THOMAS MONK NEWELL.

IT is with regret that we announce the death of Mr. T. M. Newell, formerly the Engineer-in-Chief of the Mersey Docks and Harbour Board, which took place at a Birkenhead nursing home on the 20th inst., following a severe operation. Mr. Newell had been in poor health for a considerable period.

Thomas Monk Newell was born in Seacombe, Cheshire, in 1863. He was the son of Mr. John F. Newell, a partner in the firm of Monk and Newell, Liverpool, well known as railway and dock contractors. Mr. J. F. Newell, now ninety years of age, attended the funeral of his son at Woodchurch, near Birkenhead, on January 22nd.

T. M. Newell, on leaving school in 1881, became a pupil of the late George Fosbery Lyster, then Engineer-in-Chief to the Mersey Docks and Harbour Board. After completing his pupilage he was retained on the staff of the Board as an assistant engineer. Among the works of which he was in charge during this period of his career was the pumping station at the Coburg Dock for the impounding of water in the Southern Docks at Liverpool.

In January, 1889, he left Liverpool to become chief assistant engineer to the Hull Docks Company, which concern was amalgamated in 1893 with the North-Eastern Railway Company. In less than a year after his first appointment he became the chief engineer for the docks on the retirement of Mr. Morrillan from that position. In 1900 he was appointed chief docks engineer to the North-Eastern Railway Company, and from that time until he went to Liverpool he was responsible for all the company's dock undertakings on the North-East Coast of England, with the

exception of the staiths in the river Tyne and at Blyth. During this period he carried out a number of dock improvements, including the extension of the St. Andrew's Dock, a new entrance to the William Wright Dock, and the construction of the riverside quay at Hull. At Middlesbrough the dock equipment and approaches were improved, and the old Victoria Dock at Hartlepool was deepened, converted into a tidal harbour and provided with new quays. At the West Hartlepool docks Newell constructed a new entrance from the tidal or west harbour to the Union Dock. He was specially interested in the improvement of coal-shipping appliances, which in the ports of the North-East Coast of England form a principal part of dock equipment, and was a pioneer in the adaptation of belt conveyors to the shipment of coal. Not only were coal conveyor belts installed at existing staiths, such as those at Tyne Dock and Hartlepool to improve the shipping facilities and increase the available height of shipment, but entirely new installations on a large scale were constructed under his direction, particularly at Hull, where conveyor installations by which the coal was raised from quay level to the shipping point were erected. His principal work at Hull was, however, the design and construction of the Hull Joint Dock, for which he was responsible with the then engineer of the Hull and Barnsley Railway Company. The new dock, now known as the King George Dock, was opened in the summer of 1914 after Mr. Newell had returned to Liverpool, where, in 1913, he succeeded the late Anthony George Lyster as Engineer-in-Chief to the Mersey Docks and Harbour Board.

Newell's greatest achievement was the construction of the Gladstone Docks system, which occupied him throughout practically the whole of his service as Engineer-in-Chief to the Board. The Gladstone Docks at the southern end of the long water front on the Liverpool side of the Mersey were designed by Mr. A. G. Lyster, but the execution of the greater part of the scheme fell to be carried out by his successor. In all, over £8,000,000 have been expended in the construction of these works. The wet dock was opened by H.M. the King in 1927. Among other important works carried out by Newell on the Mersey were the improvement of the Birkenhead docks, including the construction of a new river entrance to the Alfred Dock; the re-equipment of the docks with mechanical appliances; and the partial reconstruction and improvement of many of the older docks. One of the most difficult problems with which he was called upon to deal at Liverpool was the improvement and maintenance of the sea channels of the river Mersey. In the time of his predecessor it became necessary to supplement the intensive dredging of the bar and river channels, required to maintain deep-water access to the port, by the construction of revetments and training walls on a large scale. This work was continued and extended by Mr. Newell. The problems involved in the maintenance of the sea channels of the Mersey are not the least of the difficulties which remain to be overcome by the Dock Board and its engineers, and since his retirement in 1928 Mr. Newell continued as the Board's consulting engineer, to advise it in regard to further schemes for improving and stabilising the deep-water approaches.

Newell's work, both at Hull and on the Mersey, was marked by thoroughness and solidity. Every detail was carefully thought out and provided for. The cost of the works he was called upon to execute probably had less influence with him than the desire to secure a durable and permanent structure of the highest efficiency. He was often consulted concerning important dock undertakings elsewhere, notably in connection with the famous dispute over the Tanjong Pagar Dock contract. He visited Singapore to investigate the matters in dispute, and thereafter gave important evidence in the Chancery Court.

Mr. Newell became an associate member of the Institution of Civil Engineers in 1889, and was transferred to the class of member in 1898. He was a Lieutenant-Colonel in the Engineer and Railway Staff Corps, R.E. (T.). One of his sons is an assistant engineer to the Mersey Docks and Harbour Board, and his youngest son was killed in 1914 at the first Battle of Ypres.

ELECTROLYTIC condensers on A.C. circuits, states Mr. F. W. Godsey, in a paper to be read before the American Institute of Electrical Engineers, have higher power losses than would be expected from the leakage currents and electrolyte resistances. Losses change with the applied voltage, temperature of the cell, the frequency of the applied voltage, and with external circuit conditions governing current wave shape in such ways that it is almost impossible to predict results in advance. When a sine wave of voltage is impressed the current wave usually contains large harmonics, indicating a non-linear function in the impedance of electrolytic condensers. Increases in voltage, temperature, frequency, and concentration of the electrolyte also cause increases in the harmonics in the current wave. A film on the anode surfaces saturated with the electrolyte solvent would explain the characteristics as measured and also make it possible to predict characteristics with some accuracy. Ion penetration of the outer regions of the film, and a comparatively continuous film near the anode, explain the non-linear characteristics. The variation of the electrolyte potential can be predicted on this basis, and power losses also are more easily predictable.

Oil-Electric Rail Cars on the Pamplona San Sebastian Railway.

IN November, 1927, the Sociedad Minera Guipuzcoana was authorised by Royal Decree to contract with the Compania Auxiliar de Ferrocarriles and William Beardmore and Co., Ltd., of Glasgow, for the construction of three 200 B.H.P. oil-electric rail cars for the Pamplona San Sebastian Railway. These cars were built by Clayton Wagons, Ltd., of Lincoln, and were engined by Beardmore's and were set to work towards the end of 1928. One of the cars is shown in the accompanying illustration.

The following notes and figures are taken from an official report submitted to the Railway Council of Spain by Senor H. de Azqueta, dealing with the tests made with the cars, which has been placed at our disposal by William

200 B.H.P. BEARDMORE OIL-ELECTRIC RAIL CAR

Beardmore and Co., Ltd. It may be of interest to recall that the rail cars referred to took the place of steam locomotives supplied by Maffei about 1913, which were of the 2–6–4 type with a Stutz swivel tender. The locomotives each weighed 60 tons, or 64 tons when filled with fuel and water. The total wheel base was 31ft. 6in. and the rigid wheel base 9ft. 2½in., with approximately 51in. diameter driving wheels. The approximate length over buffers was 42ft. 5in., and with a boiler pressure of 175 lb. per square inch about 700 horse-power was developed, passenger trains of from 70 to 105 tons being hauled.

The line of the Pamplona San Sebastian Railway Company has a length of 91,600 m. and is 1 m. gauge, running *vid* Lasarte and Plazaola in the Province of Cuipazcoa.

The profile of the line is extremely irregular, with gradients of as much as 27 mm. per linear metre. The datum level is 6 m. above sea level in San Sebastian, 645 m. above sea level at the principal divisionary line, which is 50,300 m. from San Sebastian, and 448 m. above sea level in Pamplona. The outline in plan is extremely sinuous in a section of 20,200 m. in length between Andeain and Plazaola, in which there are eighteen curves with a radius of 80 m. and twenty-one curves with a radius of 90 m., and as many as twenty-nine tunnels of very small section.

The 200 B.H.P. Beardmore oil-electric rail cars are used to provide a regular service of passenger trains between San Sebastian and Pamplona, each rail car hauling two trailers weighing 16 tons each, making a total weight of train of approximately 67 tons. The cars are designed to carry twelve first-class and eighteen third-class passengers and are complete with lavatory and luggage compartments.

Principal Particulars.

Gauge of line	1 m.
Weight of rail car empty	33,300 kilos.
Weight of rail car loaded	35,800 kilos.
Weight per axle—	
At bogie, engine end of car	9500 kilos.
At bogie, passenger end of car	7150 kilos.
Maximum width of rail car	2·18 m.
Maximum height of rail car	3·25 m.
Maximum length over buffers	15·02 m.
Speed on level	60 kiloms. /hour

Engine Particulars and Weights.

Number of cylinders	Six
Bore	165 mm.
Stroke	228·6 mm.
Engine revolutions per minute	600 to 1250
B.H.P.	200
Weights—	
Diesel engine and underbed	1910 kilos.
Dynamo and exciter	2142 kilos.
Radiators and ventilators	658 kilos.
Electrical control panel with control apparatus and cables	1020 kilos.
Four traction motors with gearing	4200 kilos.
Accumulator and controllers	1200 kilos.

Since February, 1930, the report states, oil-electric rail cars have maintained the whole of the passenger service on the line from San Sebastian to Pamplona, there having been two rail cars always in service, each one operating a daily run of 200 kiloms.; furthermore, during the four months of summer and autumn the volume of traffic made it necessary to have the three rail cars in service, the third rail car being used to carry out a short-distance service and to give double traction to the other trains when and where necessary.

From February, 1930, until the end of 1931 each rail car had completed the following number of kilometres:—Rail car No. 1, 68,033; rail car No. 2, 87,821; rail car No. 3, 87,020.

LOADS HAULED AND FUEL CONSUMPTIONS.

The train hauled by each rail car, at the speeds indicated in the time schedule, on the line from San Sebastian to Pamplona, was made up as follows:—One rail car, 35,850 kilos.; two passenger coaches, 32,000 kilos.; total, 67,850 kilos. However, the normal passenger train during the greater part of the year was composed of:—One rail car, 35,850 kilos.; one passenger coach, 16,000 kilos.; one goods van, 8500 kilos.; total, 60,350 kilos.

The average consumption of fuel—gas oil—during 1930 was:—Per train-kilometre, 0·8288 kilos.; and per ton-kilometre, 0·0137 kilos.; while the consumption of lubricating oil by the oil engine was:—Per train-kilometre, 0·0464 kilos. The prices of fuel and lubricating oils in Spain—Guipuzcoa—it may be noted, were:—Gas oil, 230 pesetas per ton; lubricating oil, 3·80 pesetas per kilogramme. The lubricating oil, we may remark, can be re-used after filtering, thereby giving an economy of approximately from 30 per cent. to 40 per cent., which, however, has not been deducted from the lubricating oil consumption stated above. We understand, however, that the question of filtering the used oil is being considered with a view to installing the necessary plant.

Comparison of the cost of steam traction only during a period of six months, with that of Beardmore oil-electric traction only for the same period of time, gave the following figures:—Cost per train-kilometre: Steam traction, 1·536 pesetas; oil-electric traction, 0·711 pesetas; in which figures are included, we are informed, all costs of the *personnel* necessary for driving, maintenance and repairs, fuel, lubricating oils, and all materials used in maintenance and repairs—that is, all the expenses, with the exception only of interest on capital and amortisation of the rail cars and locomotives.

A perusal of the report we have referred to shows that the rail cars have fulfilled completely all the tests specified in the contract and have been taken over by the company operating them. They have given great regularity of service, and the individual cars have been in service for periods of more than three months without the engines having to be cleaned or inspected. The usual time allotted for cleaning and inspection is from three to four days every three to four months, and the maintenance has been found to be simple, with a minimum of cost. In concluding his report, Señor Horacio de Azqueta states that in order to obtain the full economies and convenience offered by oil-electric traction and to replace entirely the steam traction, six further oil-electric units will be required for passenger service and two further units for goods service, these latter operating at slower speeds with heavier loads. In the new units, engines of about 360 B.H.P. will be employed, giving a larger power, which the service really calls for.

A Water Level Indicator for Overhead Tanks.

WE recently examined a very simple and ingenious form of overhead tank water level indicator, which has been invented and provisionally patented by Mr. Sidney A. M. Rose, consulting engineer, of 4, Hurlingham Court, S.W. 6, and is manufactured by the Budenberg Gauge Company, Ltd., of Broadheath, near Manchester. The gauge, which

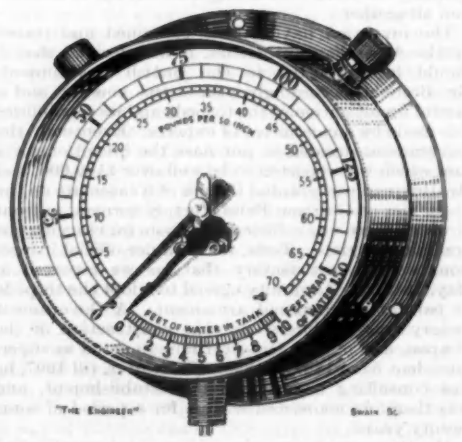


FIG. 1—VIEW OF GAUGE

we illustrate herewith, has been specially designed to meet the requirements of engineers in charge of heating systems or other like installations in which an overhead water tank is employed. In connection with such plants instances sometimes occur in which, on practical grounds or by reasons of economy, it is not possible to fit one of the more elaborate tank depth indicators of the pneumatic or float-operated pattern with mechanical or electrical trans-

mission, and an ordinary dial pressure gauge has to be employed which is fitted below the tank and connected with it by a pipe. On such dial gauges the part of the scale available for the indication of the water level is often quite small and of little practical use.

In the gauge we are describing—see Fig. 1—a separate very open scale is provided, on which a red pointer indicates directly the feet of water in the tank or, if desired, its contents in gallons or other convenient units. As Fig. 2 indicates, the red pointer is actuated by the Bourdon tube movement through a pick-up device comprising an adjustable two-toothed sector mounted upon the same spindle as that to which the main gauge pointer is attached. The sector can be set in any position by means of a knurled clamping nut, and the teeth at its lower end engage with a pinion to which the tank depth pointer is attached. The pointer system is so designed that when the toothed sector disengages itself from the pinion the pointer tends to gravitate by means of an overbalancing arrangement to that end of the scale it happens to be nearer to. In actual operation the lower pointer is so set that the sector engages with the pinion immediately water enters or begins to rise in the tank. Thus if the tank is situated, say, 75ft. above the level at which the gauge is fixed, then the depth pointer will begin to move in the opposite direction to the main pointer as soon as the 75ft. mark on the main scale is reached and will indicate 5ft. of water in the tank when the main gauge pointer indicates a total head of 80ft. In addition to the depth of water scale being a very open one, the arrangement of pointers has, it is claimed, the advantage that the head of water in the overhead tank can be readily estimated from the angular position of the red pointer at a distance at which the main scale and figures cannot always be seen clearly. When the water rises above

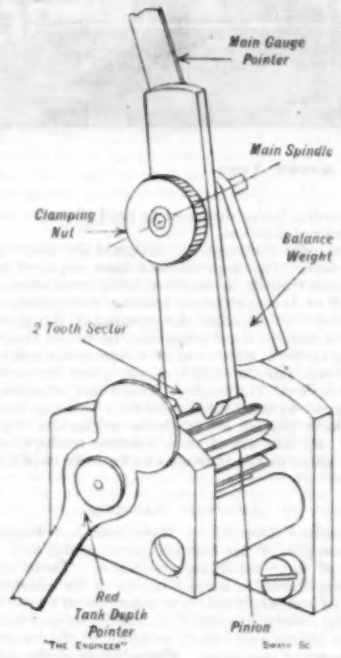


FIG. 2—ARRANGEMENT OF POINTER DRIVE

a certain level the sector arm disengages itself from the pinion so that the main gauge pointer can travel on. Internal electrical contacts are also provided and can be set so as to give either an audible or visible signal when any desired depth of water is reached. The simple adjustment of the sector on the pointer spindle allows the gauge to be readily set for working at any distance below the tank and, if so desired, two or more gauges giving synchronous readings can be used on different parts of a building heated by water or hydraulic installations in which an overhead tank is utilised.

ELECTRIC ARC WELDING IN SHIPS.

AT the end of last week the British Corporation Register of Shipping and Aircraft issued a booklet of provisional rules for electric arc welding in ships. It is stated therein that—"As uniform results are inconsistent with variations in electrodes, electric current, or in the rate at which welding material is deposited, it is essential that all welding shall accord exactly with the conditions which governed the acceptance tests." The acceptance tests mentioned in the paragraph quoted are detailed in the booklet. Regarding operators, it is stated that welders are to be trained operators in the class of work on which they are engaged, and that care is to be taken that every weld is made in the manner approved at the acceptance tests. The surveyors are to check the methods of the operators from time to time. The current used in the welding operations is not to be more than 7½ per cent. over or under that used for the acceptance tests, while the electrodes are to be of approved sizes and types. Particulars are specified of the manner in which the weld material is deposited. Under the heading "Lay out," it is stated that care is to be taken to lay out the work so that as much as possible is done under cover and before being erected in position, and that overhead welding should be avoided. Recommended methods of making various types of welds follow. The Corporation appends in the booklet the revised text of the amended sixth paragraph of Section I. of the rules for the construction and classification of steel ships and their machinery, 1931, which reads as follows:—

"In no circumstances shall the committee or the society be held responsible for inaccuracy in any report or certificate issued or published by the society or its surveyors, for any entry in the register book or other publication of the society, or for any error of judgment, fault or negligence on their own part or on the part of their officers, servants, or agents. The society's certificates automatically lapse when there is any damage to or defect in the ship which affects their validity, and they remain invalid until such damage or defect is made good to the satisfaction of the committee. The continuance of the classification of any ship is conditional upon the rule requirements for special periodical, damage, and other surveys on the hull and machinery being duly carried out. The committee reserve to themselves the right to reconsider, withhold, or suspend the class of any ship, or any part of the machinery or equipment, for non-compliance with the rules, for defects reported by the surveyors which have not been rectified in accordance with their recommendations, or for non-payment of fees which are due on account of classification and other surveys."

A New High-Speed Heavy-Oil Engine.

BRIEF reference was made in the course of Dr. S. J. Davies' paper on "Some Characteristics of High-speed Heavy-oil Engines," published in our issue of December 25th—see page 681—to the Petter high-speed heavy-oil engine, and a diagrammatic drawing of the combustion chamber was given, along with some of the principle dimensions of the new engine.

We have now received from Petters Ltd. some further

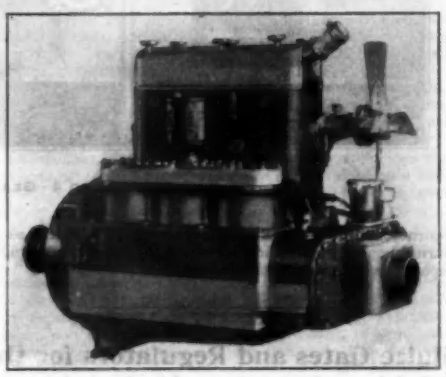


FIG. 1—THREE-CYLINDER HEAVY-OIL ENGINE

particulars of this engine, together with the accompanying illustrations. Fig. 1 shows the general appearance of the motor which operates, it may be recalled, on the two-stroke cycle, single-acting principle. It has three cylinders, each with a bore of 4¼in. and a stroke of 5½in., and is designed to develop 36 B.H.P. at 1200 r.p.m., the maximum speed being 1600 r.p.m., corresponding to an output of about 50 B.H.P. Separate scavenge pumps of the piston type are provided for each cylinder, and they are chain-driven at engine speed. The pumps will be seen at the front of the engine in Fig. 1. The "Protectomotor" air filter on the air inlet connection, immediately above the scavenge pump covers, will also be noted. The fuel pumps and fuel injectors are of the "Bosch" pattern, and are designed for a working pressure of about 2100 lb. per square inch. The compression pressure in the main cylinders is round about 450 lb. per square inch, and the maximum combustion pressure approximately 700 lb. per square inch. The brake mean effective pressure is 42 lb. per square inch, and the fuel consumption about 0·42 lb. per B.H.P.-hour. As Fig. 2 indicates, the com-

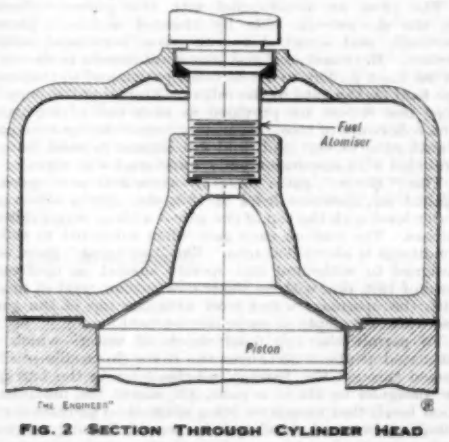


FIG. 2 SECTION THROUGH CYLINDER HEAD

bustion chamber is domed in shape and is very simple in form.

The fuel pumps, water circulating pump and the dynamo are all chain-driven, the chains being housed within an oil-tight casing in which a constant oil level is maintained, thereby ensuring effective lubrication. A governor is coupled to the fuel pump shaft, and it cuts out the fuel pumps when the engine reaches its maximum speed. It further controls the fuel delivery at the various running speeds and provides for a slow-running speed of about 300 r.p.m. An electrically operated starting arrangement is provided, the pinion of the starting motor engaging with a gear ring on the fly-wheel. Forced lubrication by means of a gear pump and oil filter supplying oil to all important parts of the engine, is provided, and by the removal of the oil sump, complete access to the main bearings and bottom ends is given.

The engine bed-plate has been designed for either three-point or four-point suspension. The monobloc cylinder casting is secured by through-going bolts to the inverted main bearing caps so that the combustion forces are not transmitted through the crank case casting which only carries the weight of the engine. In the design of the engine parts Alpax aluminium alloy has been freely employed, together with other special materials, and the weight of the complete engine works out at about 12 cwt.

THE STATE OF GERMAN INDUSTRIES.—In a recent publication of the D.O.T., which reviews the economic conditions in Germany to September, 1931, considerable space is devoted to an appreciation of the position of the major German industries, their volume of production, markets, competitive power, &c., and the position of the various syndicates being indicated. There is ample evidence in this chapter of a very interesting report that all branches of economic life were affected by the general depression to a greater or less degree. The output of pig iron in 1930 was the lowest but one since the war, and production continued to fall during the first half of 1931. The output of ingot steel was the lowest since 1924 and was 29 per cent. below that of 1929. Exports of machines, including electrical, constituted a record in 1930, but fell off during the first six months of 1931. The shipbuilding industry suffered a set-back in 1930, and the motor car industry in 1929, from which neither has recovered. Chemical exports declined in value by about 17 per cent. in comparison with 1929. The textile industries were severely depressed, exports of cotton goods falling in 1930 to Marks 357,620,000, the figures for 1929 being Marks 475,310,000. The observations contained in the report are amplified by the relevant statistical material and there are the usual appendices setting out the foreign trade of Germany in detail.

MANUFACTURE OF FOREIGN GOODS IN BRITAIN.—The Principal, Publicity Department, London Chamber of Commerce, 97, Cannon-street, London, E.C. 4, is anxious to obtain the names of manufacturers who are in a position to manufacture foreign goods under licence or on a royalty or contract basis. In some cases the inquirers are willing to transfer their whole plant to this country and to work in co-operation with British manufacturers. A number of these inquiries have already been dealt with, but there are still a number waiting to be fixed up; for instance, enamelled advertising signs, milling machines, woollens and worsteds, hosiery, enamelled copper wire, insulating materials, bakelite sheets, &c., covered enamel connecting wire, wires, silk and cotton covered; zinc cups for dry batteries, either drawn, soldered or welded; radio flex in cotton and rubber, felt, brass parts for dry batteries, knitwear, Bakelite panels, wood separators for accumulators, portable typewriters, special locking washers, thermostats, varnished tapes, adding machines and component parts, cotton insulating tapes, Presspahn, sheet; plugs and sockets, banana, two-pin, wander, &c.; varnished insulating paper and cloth, moulded knobs, flash lamp bulbs, carbon rods, sealing compound for batteries and condensers, bobbins—choke, loud-speaker, headphone, transformer; all kinds of cardboard, papier-maché and compressed bakelite, belts, "V"; typewriters and component parts, insulating materials, bakelite, sheet, rod and tube, for high-tension apparatus, switchgears, transformers, &c. The inquirers desire to be put into touch only with actual or potential manufacturers of these products.

BRITISH CHEMICAL STANDARDS.—The British Chemical Standards Movement held a meeting of co-operators at York on Saturday, January 23rd, at which the report on the fifth three-years' working, viz., up to September 15th of last year, was presented. This body, although British in origin, is now international, and produces standard analysed samples used all over the world by means of which the reliability both of the analytical methods used for determining the composition of a large number of materials and of the correct working of them can be verified; in fact, serving for these purposes as gauges or templates for checking sections. Apart from the commercial advantages of the accurate control of the composition of very large tonnages of materials, both ferrous and non-ferrous, a co-ordinating effect being exercised over many millions of tons, disputes and delays being largely saved, and benefits gained in many ways, another valuable result of this work is the constant investigation by the co-operators of the methods themselves, whereby any weaknesses are detected and eliminated. Outlines of the methods used by each chemist are published on the certificates issued with each sample, so that a user of a standard can compare his own working of the methods with that of any other chemists on the identical sample. The report showed that, notwithstanding the world-wide difficult business conditions, very considerable progress had been made, not only with the number and types of standards produced, but also of users. The meeting was well attended by co-operators in the Movement from many parts of the country. Dr. J. T. Dunn, who had supported the Movement from its early days, was in the chair. The report was adopted unanimously, and also a resolution approving the manner in which affairs had been conducted.

THE INSTITUTE OF METALS.—The twenty-fourth annual general meeting of the Institute of Metals will be held in the Hall of the Institution of Mechanical Engineers on Wednesday and Thursday, March 9th and 10th, 1932. The meetings on Wednesday will be held from 10 a.m. to 12.30 p.m., and 2 p.m. to 4 p.m. On Thursday, the meetings will be held from 10 a.m. to 1 p.m., and 2 p.m. to 4 p.m. On Wednesday evening, the annual dinner and dance will be held at the Trocadero Restaurant (Empire Rooms), Piccadilly-circus, W. 1, at 7 p.m. for 7.15 p.m. At the opening meeting at 10 a.m. the reports of the Council and the Honorary Treasurer will be presented. The results of the elections of the Council for 1932–33 and of the new members will be declared. The President, Sir Henry Fowler, K.B.E., will be inducted, and will read his presidential address. The following papers will be read and discussed:—"Magnesium Alloy Protection by Selenium and other Coating Processes," by Dr. G. D. Bengough and Mr. L. Whitby; "The Influence of Temperature on the Elastic Behaviour of Various Wrought Light Metal Alloys," by Mr. Bollenrath; "Some Bronze Specimens from the Royal Graves at Ur," by Miss C. F. Elam; "The Relative Corrodibilities of Ferrous and Non-ferrous Metals and Alloys: Part III., Final Report, The Results of Three Years' Exposure at Southampton Docks," by Dr. J. A. Newton Friend; "The Age-hardening of Some Aluminium Alloys of High Purity," by Dr. Marie Gayler and Mr. G. D. Preston; "The Behaviour of Single Crystals of Bismuth Subjected to Alternating Torsional Stresses," by Dr. H. J. Gough and Mr. Cox; "The Thermal Conductivity of Some Non-ferrous Alloys," by Professor D. Hanson; "The Properties of Copper in relation to Low Stresses (the Effect of Cold-work, Heat-treatment and Composition): Part I., Tensile and Compression Tests Under Short-time Loading" by Dr. O. F. Hudson and Mr. McKeown; "Observations on the Pressure of Fluidity of Annealed Metals," by Dr. Hugh O'Neill and Professor J. N. Greenwood; "The Solubility of Aluminium in Magnesium in the Solid State at Different Temperatures," by Professor P. Saldau and Mr. Zamotorin; "Note on the Interaction of Aluminium and Water Vapour," by Dr. R. Seligman and Mr. Williams; "Intercrystalline Corrosion of Duralumin," by Mr. A. J. Sidery, Mr. Lewis and Mr. Hubert Sutton; "The Properties of Copper in relation to Low Stresses (the Effect of Cold-work, Heat-treatment and Composition): Part II., Creep Tests at 300 deg. and 350 deg. Cent., of Arsenical Copper and Silver-arsenical Copper," by Mr. H. J. Tapsell and Mr. Johnson; "The 'Fogging' of Nickel," by Dr. W. R. J. Vernon.

A New Gear Testing Instrument.

OWING to the importance of having perfectly cut gears not only from the point of view of silence, but also with the intention of attaining long life and efficiency, many instruments have been produced in recent years, which have for their object the measurement of inaccuracies in the cutting of gear teeth. Most of these instruments have belonged to the laboratory class, while those designed for the workshop have been, comparatively, much cruder. A new instrument, produced by David Brown and Sons, Ltd., of Huddersfield, has been designed to be a simple, and yet very accurate and reliable, mechanism for testing the involute profile of teeth on spur and helical gears. It is claimed by the makers that it is very easily and

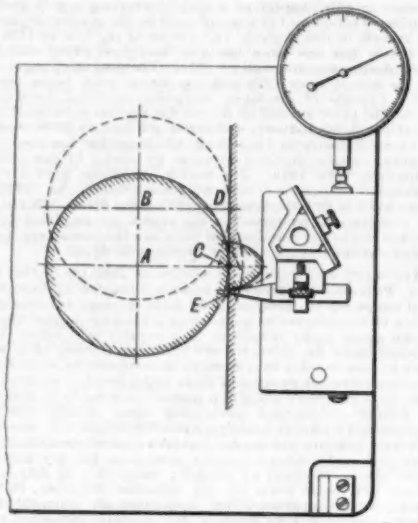


FIG. 1—PRINCIPLE OF GEAR TESTER

rapidly operated to give an accuracy to one ten-thousandth of an inch, and that it is equally useful for testing special gears, such as master gears or for repetition work.

The new instrument, which is illustrated by an engraving and drawings on this page, operates on the principle indicated in Fig. 1. In this drawing there is shown a gear wheel A, of which the base circle makes contact with a straight edge at C. In contact with the base of a tooth at E there is a stylus point. If the gear wheel is now rolled about its base circle along the straight edge to the position B, the stylus point, while remaining in contact with the face of the tooth, will not move in any direction, providing that the tooth is truly involute in form. Any deviation from that form will result in a movement of the stylus point, and such a movement can be recorded on a dial.

The construction of the instrument can be followed from the drawing, Fig. 2, and the photographs reproduced in Figs. 3 and 4. Upon a flat base plate a disc equal in diameter to the base circle of the gear to be tested is placed

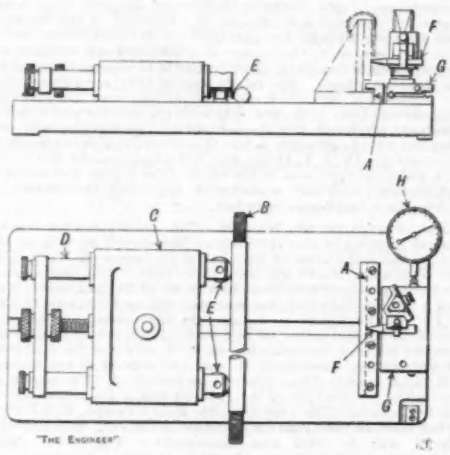
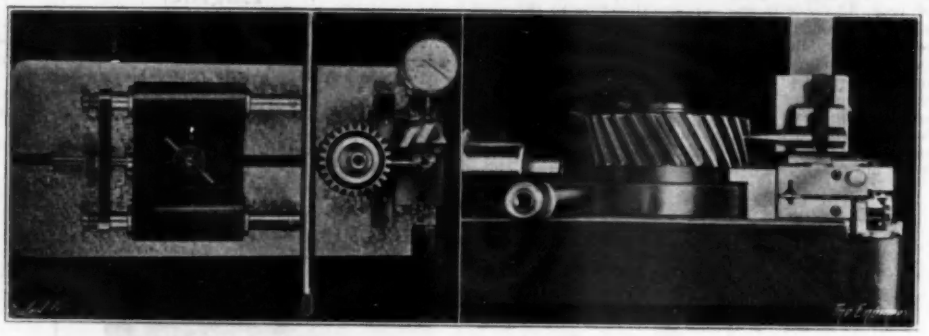


FIG. 2—ARRANGEMENT OF TESTER

in contact with a straight-edge A. The gear itself is carried on an arbor mounted upon the disc and truly concentric with it. The teeth of the wheel project over the top of the straight edge, which is made with a height low enough to allow this to occur, and is also provided with an overhang, which prevents the base disc rising from the base plate. A round steel rod B is placed against the face of the base circle disc on the side opposite to that in contact with the straight edge, and movement of this rod to and fro drives the base disc by friction, so that it rolls on the face of the straight edge. Sufficient compression is given by means of a slide C provided with two plunger rods D, made of case-hardened steel, accurately ground and polished, sliding in hardened bushes and each carrying at its end nearest the gear being tested a ball bearing E. The latter abut against the round steel rod and are so arranged that movement of this rod is made free. At the back of the slide, which can be moved in or out as a whole, and be locked in any position by the turn of a nut, the two plunger rods are connected together by a hardened steel tie bar, through which, at its centre, passes a screwed bar connected to the slide. By tightening a knurled nut on this screw, the plungers can be forced against the round steel rod with any required degree of pressure. The stylus point F recording deviations from the true involute form is mounted upon a V bracket behind the straight edge. It can be moved vertically up and down a triangular section pillar. The pillar is mounted upon a carriage, which is itself carried on a block G on ball bearings running in grooves cut, in both the block and the carriage, perfectly parallel to the face of the straight edge. A light spring tends always to pull this carriage in such a way that the stylus point is in contact with a tooth while a clock gauge H is mounted upon the base plate and has its recording rod abutting against the carriage, so that any movement of the latter is indicated by the needle of the gauge. The end of the stylus point is conical in form, and it is accurately located in the same vertical plane as the straight edge. This location is obtained by the use of a special cast iron angle bracket, as shown in Fig. 2.

The instrument, which is capable of accommodating gears up to 12in. in base circle diameter, records directly on to the dial with a sensitiveness to one ten-thousandth of an inch any deviations from the correct involute form. It is claimed that this high degree of accuracy can be constantly maintained, since there are no journal bearings or sliding ways which, when worn, might impair the accuracy of the instrument.



FIGS. 3 AND 4—GEAR WHEELS UNDER TEST

Sluice Gates and Regulators for the Sukkur Irrigation Undertaking.

SLUICE GATES IN THE BARRAGE.

As was explained in the article which appeared in our issue of January 22nd, sluice gates are provided for controlling the sixty-six openings in the Sukkur Barrage to maintain the river water at the level required for the take-off canals on each bank of the river. These sluices are of the "Stoney" type, and were manufactured by Ransomes and Rapier, Ltd., London, Ipswich, and Bombay. The design of the gates and other parts embodies the latest improvements which the firm has been able to introduce as a result of its experience in this class of work. Each gate has a clear width of 60ft. Fifty-four of them are each 18ft. 6in. deep, and are arranged in the "River" or central part of the barrage. The remaining twelve gates are 22ft. 6in. deep, and occupy positions near the river banks, seven being at the left-hand end and five at the right-hand end of the Barrage. These twelve deep or "scouring" gates have sills at a level of 1ft. below the sill level of the "River" gates, and are, of course, raised when required to keep the river bed, near each bank, clear of silt deposits and thus prevent the silt passing into the canals.

The gates are constructed with skin plates stiffened on the downstream side by channel members placed vertically and attached to two main horizontal lattice girders. Machined steel end beams are framed to the ends of the main girders to act as roller paths, and to transmit the load on the gate to the rollers. Frames of "Stoney"-type free rollers are provided at each end of the gate. The rollers are of steel, accurately turned to ensure equal distribution of the load, and are housed in steel frames provided with suspension pulleys and steel wire ropes.

The "River" gates have to withstand and operate against an upstream head of 18ft. 6in. above sill—viz., water level with the top of the gate—with no water downstream. The load on each gate when subjected to those conditions is about 300 tons. The "scouring" gates are designed to withstand and operate against an upstream head of 19ft. 6in. with no water downstream, and at times with the upstream water level with the top of the gate and with 18ft. depth of water downstream.

To permit the full flood depth of water—which is estimated at about 23ft. over the River sluice sills—to be passed through the barrage, all the gates in the barrage are designed to lift to a point 8ft. above the maximum flood level, that clearance being allowed to provide for a possible abnormal flood and to permit floating matter, such as trees, &c., to pass through the openings without obstruction.

The gates are arranged to work in grooves in the piers, in which steel roller paths of the self-adjusting type are mounted on machined castings attached to the masonry work. For the purpose of protecting the rollers and roller paths when the gates are raised and the flood water is being discharged, specially shaped shielding members are fitted in the grooves.

Self-adjusting metal staunching bars are mounted at the ends of the gates and arranged to bear on to machined cast iron members attached to the grooves in the piers. The lower edge of each gate is fitted with a teak timber arranged to form a tight joint between the gate and a machined steel sill member built into the floor.

For the suspension of each gate, steel wire ropes are attached at each end. These ropes pass over winding barrels, which are operated by gearing, and thence round pulleys carried at each end of the counterbalances to adjustable fixings attached to the gear supports. For the adjustment of the suspension ropes, couplings are provided on the cross shaft which connects the winding barrels to the operating gear, and there are special devices to facilitate the easy removal and replacement of the gate and counterbalance suspension ropes when required. The counterbalance provided for each gate consists of a steel box filled with about 70 tons of sand ballast. The boxes are about 60ft. long and are arranged to lift and lower on the upstream side of the gates. When the gates are fully raised, the undersides of the counterbalances are level with lower edges of the gates.

The operating gear for each gate consists of a central unit containing machine-cut spur gear reductions connected by means of a cross shaft to two end crabs containing further spur reductions and the winding barrels. The gearing is mounted on steel supports arranged to bear upon the concrete arches. The central gears and end crabs are completely covered by metal casings, and the shaft bearings have special rings to prevent the ingress of grit. The central operating gear is furnished with an automatic self-sustaining brake designed to hold the gate suspended in any desired position.

The gear for each gate is designed for easy operation by two men. The approximate time required to lift or lower a gate through a height of 32ft., even when they are subjected to the maximum loading conditions, is about 50 minutes. To expedite the opening of the gates in the event of a sudden flood occurring, however, there are six travelling trolleys, which can be connected, when required, to the crank handle shafts of the gears by means of a coupling device. The trolleys, which carry electric motors, are equipped with lengths of cable, which can be plugged into sockets placed at intervals along the top of the barrage. By the use of these electric trolleys, all of the sixty-six gates in the barrage can be fully raised in about 1½ hours.

ERECTING MACHINES.

The method adopted by Ransomes and Rapier, Ltd., for the erection of the barrage gates, gears, &c., involved the use of four travelling machines. These machines, which were shown in service in one of the illustrations in our issue of January 22nd, were constructed by the firm, and proved extremely successful in dealing expeditiously with the large pieces and heavy weights of the various component parts of the gates. The sections of the gates were brought along the Barrage by light railway to positions on the completed portions of the barrage, and there assembled.

The machines, which are each capable of lifting and travelling with a load of 25 tons, were operated in pairs—one pair at each end of the barrage—when handling the completed gates and transporting them to the openings as the work of building the barrage from each river bank proceeded. They are of the electric travelling "Goliath" type, and are provided with travelling crabs to enable the counterbalance boxes and gear, &c., to be handled and placed in their allotted positions.

The value of this method of erection was, we are informed, proved by the fact that the opening of the Barrage could take place earlier than had at first been intended. It had originally been planned to open the Barrage in March next, but owing to the rapid progress of the masonry construction, the programme was put forward by two months. Naturally the delivery and erection of the gates had to be similarly advanced, and it was the rapid and flexible system of erection, combined with the speeding up of work in this country, which allowed this to be done.

CANAL HEAD REGULATORS.

The canal head regulators are placed on each bank of the river immediately upstream of the ends of the barrage. There are three canals on the left bank and four canals on the right bank, and for each of the canals a series of regulators is provided. There are fifty-five canal regulator openings, each 25ft. clear span, and the gates for each opening are formed in three sections, each working in separate grooves in the piers, in the following manner:—The lower gate is placed immediately downstream of a masonry sill, with the middle and top gates placed in close proximity to each other on the downstream of the lower gate. The lower gates for each of the regulators are 4ft. 6in. deep, but the middle and top gates each vary in depth from 5ft. 6in. to 8ft. 9in., to suit the particular requirements of the various canals.

The arrangement will allow the three gates to be lowered, when required, to the floor level of the canal. To close the canal regulator openings completely, the top gate is raised to the maximum water level and the middle and lower gates are raised an appropriate amount. At times it may be necessary to raise all the gates above flood level, and provision is made for that operation to be carried out conveniently. Under normal conditions the top gate will be regulated to permit water to be discharged over the gates into the canal. Should the level of the water in the river

fall considerably below the normal level, the top gate will be raised clear of the water surface and the discharge into the canal taken over the middle gate, which will then become the regulating gate.

The tops of each of the gates are fitted with steel plates shaped to ensure easy flow of the water over the gates. For the purpose of preventing the entry of water and possible floating matter into the grooves in which the gates operate, steel plates have been fitted to the ends of the gates and extended to a point above the discharge level. These steel plates also have the effect of preserving the continuity of the masonry pier surface, and thus promote the smooth discharge of the water. So as to render them capable of easy operation when subjected to the maximum conditions of loading, the gates are fitted with machined rollers bearing on to machined metal work fixed in the grooves. The top and middle gates are suspended by steel wire ropes connected to the steel plates at the ends of the gates in the groove recesses. These ropes pass over winding barrels and to counterbalance weights. The lower gate is operated by means of steel members connected to the ends of the gates and to screws carried by the operating gear. The gear for the lower gates is designed to be of sufficient strength to allow the lower gate to be forced down behind the sill level into an accumulation of silt in the canal bed. The design of the canal regulator is such that a large deposit of silt is not anticipated, but the provision for lowering into silt has been made, as a precaution. Machined metal bars are provided to limit leakage at the ends of the gates, and between the gates and the metal sill member, the bars between the gates being of the self-adjusting type.

The gear for operating the gates is mounted on steel supports bearing at their ends on concrete arches. One fixed electric driving unit is provided for operating any one of the six gates in two adjacent openings. The driving unit is placed centrally over one of the divide piers, and is connected by shafting to the various winding barrels and operating screws, hand-operated clutches being arranged to connect the gear for the particular gate which is to be operated. Auxiliary hand gear is also fitted to permit operation by hand power in the event of failure of current. The operating equipment is provided with weatherproof metal covers and dust-excluding devices.

All the canal regulating gates and gears were designed and constructed by Ransomes and Rapier, Ltd.

Distributary Regulators.

The distributary regulators, which were also constructed by the firm, are equipped with gates placed between extensions of the concrete piers which support the masonry road bridges. Each regulator consists of a number of gates, each gate being equipped with independent operating gears. All the gates installed—approximately 350—are of 10ft. span, the depth varying between 5ft. and 12ft. 6in. A special feature of the gate equipment for the distributary canals lies in the fact that the gates are mounted on pivots placed above water level, no fixed metal work being below that level. The pivots are carried by steel beams anchored to the concrete piers. The gates were constructed in section form to permit ease of transport over a wide area, and to facilitate assembly and erection. To prevent leakage the sides of the gates are fitted with adjustable teak staunching members which bear upon the dressed faces of the piers. At the lower edges of the gates similar timbers are arranged to form a tight joint with the floor of the opening. The gates are suspended at each end by steel wire ropes winding on to barrels connected to an enclosed worm gear. The gearing is mounted upon steel platform members, which are supported on the side piers, and the operation of the gates is effected easily by two men.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

A Stinted Market.

Business in iron and steel in the Midlands and Staffordshire is in a somewhat distressed condition, transactions being confined within narrow limits. While there has been an improvement in the galvanised sheet trade, there has been a falling away in the pig iron industry. It is true that there seems to be slightly more activity at the manufacturing works in the area, but it is not reflected in the iron and steel market as yet. Specifications for material do not increase in size, neither are there any new orders of substance being given out. Selling prices of iron and steel are much as a week ago. Disappointment is generally expressed with the trade situation and its failure to develop favourably.

Finished Iron.

The finished iron trade in Staffordshire continues depressed, and optimism amongst ironmasters is becoming less marked. Many of them complain that they can make no headway as long as they are faced with the severe competition from the Continent. They are hoping for speedy measures of protection and take pains to point out that half measures will not suffice to put the industry properly upon its feet. A tariff of 10 per cent. upon iron and steel, which in some quarters has been spoken of as a possibility, would, many ironmasters think, be useless. It certainly would not enable producers of iron for the nut and bolt and fencing trades to compete against Belgian rivals. At date Staffordshire iron for that purpose costs almost double that of Continental origin. Complaints are made of the increasing stocks of foreign iron in the Black Country. There are large tonnages in the railway sidings, works having no room for further stocks. True, much of this material was ordered last year, but deliveries have been made since the current year opened and they continue to be made week by week. Very few new orders are being given out to importing merchants at date, but that is probably due to the large tonnages already held against the contingency of an import duty. Consumers indicate that, at the present rates of consumption, they are likely to be out of the market for a long time to come. As regards marked bars, which are not affected to the same extent by foreign competition, the dull conditions ruling in the engineering industries which normally utilise that high-grade material, are responsible for the depressed situation ruling. Makers of best grade iron bars have, in some cases, commitments for about a week ahead, but beyond that there is uncertainty. Orders come in day by day and are for small tonnages for immediate consumption. Trade is no worse than it was a month or so ago, but ironmasters are not getting that steady flow of orders on which profitable output depends. Values remain firm at £12 per ton. Crown bar makers have to contend with severe internal competition, and while makers from other districts offer supplies on the Birmingham market at £9 5s. per ton local producers assert it is impossible for them to sell at below £9 15s. to £10, if they are to make any profit on the transaction. Business continues to fall away in the strip department, and orders are being eagerly sought. Mills are moderately engaged on contracts and prices are maintained at £10 10s. to £10 12s. 6d. per ton delivered.

Raw Iron.

The past week has brought some contraction of demand for Midland brands of foundry pig iron and blast-furnacemen are accordingly less well placed. The light castings trade, which for several months past has made the major demand upon the production of local furnaces, finds demand failing and, consequently, founders have cut down the tonnage of recent orders for raw material. This falling away of demand for castings is attributed largely to the postponement of development and other schemes by local authorities and by private enterprise. As there is still no indication of any expansion in demand from the heavy engineering foundries the position which has arisen is unfortunate. Midland smelters were, and still are, in a favourable trade position when compared with producers of finished iron, or with steel masters, but, if the contraction of demand from the light castings foundries persists, they may soon lose their advantageous position. Contracts on furnacemen's books are weighty, but even with specifications at recent levels, little effect has been made upon the large stocks of pig iron at the furnaces, and any further addition to stocks as a result of further curtailment of demand will occasion smelters much anxiety. It is sincerely hoped, therefore, that demand will revive not only from the light foundries, but also from the heavy ones. Work at forges and mills is generally spasmodic. Chance orders and specifications against contracts do not occupy 50 per cent. of productive capacity. Prices of pig iron are unchanged on the basis controlled by the Association, namely, £3 2s. 6d. for Northamptonshire, and £3 6s. for Derbyshire and North Staffordshire foundry No. 3. Other qualities are in proportion.

Steel.

I am unable to report any betterment of the position in the steel trade on the week. Conditions are substantially as they were a week ago with no alteration either in the volume of business passing, or in the prices paid for the various classes of material. Every endeavour is being made to bring to the notice of the Government the plight of the industry, and there seems to be an overwhelming volume of opinion in this area favourable to tariffs. Hopes are expressed that something definite will be done and before long to place producers of steel on a more even footing with their foreign rivals in the home market. Steel works in the Midlands are only working at about half capacity and orders in some departments are more difficult to get than they were a month ago. Constructional engineers are in a serious position, being at a loss to find work for their employees or yet to order steel from the rolling mills. Other classes of heavy steel are selling slowly, while special materials rolled for the motor car trade are in only moderate demand. Re-rollers are fairly engaged, but the outlook is very restricted. Billets sell slowly and in small quantities. Steel quotations for finished and semi-finished material alike are unchanged. Foreign steel is offered rather more freely, billets being quoted at about £4 10s. Foreign joists are reported to have changed hands at £4 17s. 6d. Importing merchants state they are not doing much business. There are large stocks of Continental billets in the Black Country, Indeed one industrialist asserts that such is the position of stocks generally in this area that were a tariff on iron and steel imposed immediately, it could make no appreciable difference to English works until August.

Sheet Prices Improve.

The receipt of somewhat larger tonnage orders from overseas markets, including South America and West Indies, added to the recently reported increased activity in the home market, has enabled producers of galvanised sheets to secure a more profitable figure for their output. Makers who, until recently, were prepared to sell 24-gauge galvanised corrugated sheets at £9 per ton now ask £9 5s., while others who refused to do business at the late minimum figure now quote £9 7s. 6d. For a long time now millowners have contended that selling prices were unremunerative and they have on several occasions seized the opportunity presented by a small buying spurt to raise the price level. As buying has fallen away again, prices have receded. Competition since price control was abandoned in this branch has been so keen, and business so scarce, that local mills have freely complained of the unsatisfactory conditions ruling. It is only with difficulty that operations are maintained and with under-production and low selling prices profitable business is almost out of the question. An expansion of overseas demand is much overdue, and is badly needed to place mills in a steady position.

Scrap.

The scrap market remains dull. No signs of improvement in demand for steel scrap can be discerned. A limited amount is being made at the steel works, but even so there are very few buyers. Merchants are anxious to improve on the existing scale of prices, which they consider unremunerative. Efforts to secure better terms, however, have up to now met with little, if any, success.

The Adverse Trade Balance.

Mr. H. Lakin Smith pointed out to the Council of the Birmingham Chamber of Commerce on Monday the seriousness of the trade position as revealed by the Board of Trade returns of imports and exports for 1931. The official figures showed, he said, that in 1913 our imports of manufactures amounted to £193,000,000, and in 1931 to £261,000,000—an increase of £68,000,000. In 1913 our exports of manufactures amounted to £411,000,000, and in 1931 to £290,000,000, a reduction of £121,000,000, and so, taking the two—imports and exports—together, the position was worse by £189,000,000 compared with the last pre-war year, and without taking into account changes in price and the value of money. The returns showed also that, excepting the year 1926, when there was a general strike, imports of iron and steel exceeded exports for the first time and to the amount of 870,000 tons.

Coventry Engineering.

Automobile engineers in the Coventry area find business rather brighter than it was, though the position on the whole cannot be said to be satisfactory. Work is unevenly distributed, and while some light car firms are busy, others are making only a restricted output. In the luxury car branch orders continue difficult to procure, and makers are perturbed regarding the prospects for the season. In the transport section inquiries in circulation encourage hopes of improvement in the near future. The trade tone is moderately cheerful, and there is every prospect of increased activity at the works as spring draws nearer.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

A Poor Year for Textile Machinery.

How poor have been the overseas markets for textile machinery during the past twelve months is shown by the complete returns of export business in 1931. During that period the aggregate shipments of British textile machinery amounted to 55,567 tons, valued at £5,280,713, including 39,547 tons of spinning and twisting machinery of the value of £3,827,001 and 11,743 tons of weaving machinery valued at £882,038. The year's totals compare with 91,212 tons and £8,628,162 in the previous twelve months, and 126,553 tons and £11,643,902 in 1929. Needless to say, the past year's formidable contraction has been reflected in varying degree in the exports to all markets, with British India herself, for political as well as economic reasons, accounting for a large proportion of the decline. Details of the year's exports, with the comparative figures for 1930 in parentheses, are as follows:—British India, £1,749,429 (£2,513,439); France, £441,258 (£835,657); China, £406,707 (£706,562); Japan £263,368 (£434,609); South America, £236,627 (£242,240); Germany, £218,896 (£382,455); the Netherlands, £200,262 (£386,267); the United States, £159,454 (£305,564); Russia, £157,175 (£761,909); and Australia, £82,233 (£192,988); aggregate shipments to "other European countries" in 1931 were valued at £988,513, compared with £1,449,481 in the previous year.

"Safety First" in Engineering.

A striking example of the reduction in accident rate in an important engineering establishment in Manchester was furnished by Mr. L. E. Mather, chairman of the Manchester Industrial Safety Council, at the first annual dinner of that body. Mr. Mather stated that since his firm had been associated with the Safety-First movement, their accident rate had been reduced from 5 per hundred employees per year to 1·45 in 1931, which compares with 1·74 in 1930. The decrease had, he said, been gradual, and they did not see much chance of reducing it lower than 1·45, but they were sure they could keep it there by working through the works committee. In 1928 the total number of working days lost by their workmen was 1550; in 1931 it was only 650 days.

Oil Engines for Private Cars.

Interesting details of the performance of a private motor car fitted with a heavy-oil engine have been furnished by Mr. J. H. S. Gardner, of the firm of L. Gardner and Sons, Ltd., of Patricroft. Mr. Gardner had fitted to his own car a standard high-speed engine, similar in model to those already in use on the road in 5-ton goods vehicles, and in motor omnibuses. The petrol consumption of the car fitted with its original engine was in the region of 15 miles to the gallon; with heavy oil, Mr. Gardner, who has been carrying out extended running tests, has on three occasions done 32, 34, and 34½ miles to the gallon, at a fuel cost equivalent to about one-eighth that with petrol. On more than one occasion during the tests, a speed of over 80 miles an hour was reached. Mr. Gardner admits the difficulties in the way of making a small enough engine for private cars, but he has no doubt that in time the necessary adaptations will be made.

Bridge Approaching Completion.

During last week-end a half section of the new steel bridge at Carr Mill, St. Helens, which is to carry the London, Midland and Scottish Railway Company's main line from Liverpool to Wigan over the new Liverpool–East Lancashire road, was placed in position, and the present plans are for the other section to be placed in position at the end of next week. Each section weighs in the aggregate about 600 tons. The steel was fabricated at the Arrol Works, Glasgow.

Non-ferrous Metals.

There has been little of a cheerful nature to report concerning the non-ferrous metals market during the past week, although, apart from a further slight loss in the tin and copper sections, the market has finished up reasonably steady, with lead maintained at the levels current a week ago and spelter a shade higher. In the case of tin, there has been a fair aggregate movement of the metal, but the bulk of it has been on speculative account. Conditions in the South Wales tin-plate trade are regarded as relatively satisfactory, but in other respects, the consuming industries in this country, as well as on the Continent and in the United States, are not such as to make for any material increase in the demand for tin. Quotations are about 10s. a ton cheaper than they were a week ago. The call for copper has been poor, and with confidence in the stability of the metal still lacking, values have further eased, although only to the extent of about 5s. a ton for standard brands. Interest in lead has been on a rather quiet scale, and the demand from actual users has been very moderate. On balance, however, prices are much as they were a week ago. The movement of spelter has also been on a restricted scale, but, presumably on a slight improvement in the statistical position of the metal, values have moved up a few shillings and part of the recent loss has been recovered.

Iron and Steel.

Apart from the fact that contract deliveries of foundry pig iron in the Lancashire district have been maintained at much about the recent level, there is little cause for satisfaction in the general position of the iron and steel trades. Fresh orders for pig iron are markedly restricted at the present time, both as to the number and the tonnage involved, although sellers are looking for some improvement as old contracts expire. Quotations keep up at 67s. per ton for Derbyshire, Staffordshire, and North-East Coast makes; 65s. 6d. for Northamptonshire; about 87s. for Scottish; and 81s. for West Coast hematite, including delivery in the Manchester area. The bar iron trade continues slow, with Lancashire Crown bars at £9 15s. and No. 2 quality at about £8 5s. In the steel trade, the principal depressing influence, so far as bulk business is concerned, is the continued shortage of work among constructional engineers, whose specifications of late have been reported to be worse rather than better in the aggregate. Locomotive-building firms, as well as boilermakers, are also taking only small quantities of steel, whilst forgings are in poor demand from general engineering firms. Steel prices, however, show little alteration in any direction.

BARROW-IN-FURNESS.

Hematite.

There is a little more life in the hematite pig iron market, and a few more inquiries are coming in from buyers who are likely to require deliveries shortly. Business is mostly confined to the home markets, and neither the Continent nor America have been as yet attracted by the low price consequent upon the reduced value of the pound. Still, trade is not brisk by any means, and, but for local requirements on steel account, the present output would exceed home demands. Fortunately, Barrow is now taking iron for converting and Workington will resume as soon as the dispute about the extra two hours' shift has been settled. At present, the workers are asking for time and a-quarter for the two hours' working on top of the usual eight. In the meantime, stocks are naturally going up. Iron ore continues to be in quiet demand, and is likely to remain in that position until more furnaces go in. The steel market is quiet, but there are a few orders held by both Barrow and Workington which will keep them going for a somewhat short period.

Shipbuilding.

On Tuesday Vickers-Armstrongs launched from their Barrow Naval Construction Works the super-submarine "Thames," built to the order of the British Admiralty. The launching ceremony was performed by Mrs. Backhouse, wife of Rear-Admiral R. R. C. Backhouse, Controller of the Navy. Other Admiralty orders in hand at this yard are for two destroyers, the "Cygnet" and "Crescent," which are being fitted out; two destroyers on the stocks; and a submarine of the "P" class. In addition, there is the new Furness-Withy liner for the New York–Bermuda service.

SHEFFIELD.

(From our own Correspondent.)

Steel Production.

THE statistics of the production of steel in 1931, which are now available, show a considerable decline, and in that decline this district shares. There was a heavy fall in 1930, and that, followed now by a further fall in the last year, has brought about a very serious position. In the Sheffield area—which embraces Rotherham and Stocksbridge—the output of steel ingots and castings in 1931 amounted to 786,300 tons, as compared with 965,700 tons in 1930 and 1,217,000 tons in 1929. The fall in Lincolnshire is still more marked. In 1930 that district maintained its trade to a better extent than Sheffield, and had an output of 689,000 tons, but last year the figure fell to 392,300 tons. Production is still on a low scale. In this district it is about on the same level as before the Christmas stoppage. The United Steel Companies have seven open-hearth furnaces in operation at their Templeborough works, and two at Rotherham, and output at other works remains as before. Difficulty is being experienced, however, in disposing of the production, as bulk orders and forward business are still very scarce. The position in Lincolnshire is a little better, but is still far from satisfactory.

Getting their Share.

It is satisfactory to read that, while Sheffield is not getting as much trade as it wants, it is, at any rate, getting its share of what trade is going. Captain R. S. Hilton, the managing director of the United Steel Companies, speaking at a social gathering of employees on Saturday night, expressed the opinion that the company had a future second to none in the heavy steel trade. He pointed out that three years ago it was producing 12¼ per cent. of the steel ingots in Great Britain, while to-day it was producing 15¼ per cent., which showed that it was improving. He also stated that during the past twelve months the directors had considered the advisability of closing the Templeborough melting shop and buying Continental billets to keep the strip and bar mill running. The temptation was, he said, a very serious one, as they would probably have been able to buy the foreign material at an advantage of £1 a ton. They had come to the conclusion, however, that, while as an opportunist policy it might have had its advantages, it would, in the long run, be unsound. He added that they had been breaking records so far as output at Templeborough was concerned. They were getting out more steel per furnace, and they had managed bit by bit to effect economies, all of which had made it more possible to keep the works running.

The Manufacturing Side.

There is little change to report with regard to finished steel products. On the heavy side, the plants producing hollow rolled boiler drums have a good deal of work in hand, but the railway and shipbuilding steel departments are very quiet, and there are few large engineering orders on hand. Some of the lighter branches are better situated, particularly stainless and corrosion-resisting steels, the output of which is well maintained. The volume of work for the automobile industry keeps up to recent levels, though below those of the best times. Cold-rolled steel and strip are benefiting from the fall in exchange values. The tool trades have also gained an advantage from the fall in the price of sterling and the anti-import duties. While there has not been such a big increase in sales as was looked for, demand is still growing for saws, files, and engineers' small tools, and continuous progress in the immediate future is confidently expected. There appears to be no new business being done in German tools, and few German travellers are to be seen. The prices of American tools remain steady, but it is believed that substantial increases must be imposed before long. Very fair employment is reported at the electric steel furnaces, of which there is a good number in Sheffield now. There is rather more briskness in that line at Thos. Firth and John Brown's, while Brown Bayleys' Steel Works have three furnaces in operation, and fair activity is reported by other firms. Sheffield is at present building high-frequency furnaces, of 4 and 5-ton capacity, for Sweden.

Cutlery and Plate.

Business in the cutlery and plate trades is unevenly distributed, so that it is difficult to sum up the general position. While several firms have full order books, however, the majority have restarted, after the holidays, with little work on hand, and it would appear that on the whole the present turnover is rather less than that of a year ago. Travellers for the large firms are now beginning their country journeys, and reports of the state of the home market will be available shortly. Since the opening of the year exports have compared unfavourably with last year's, but practically no foreign cutlery has come into this country for more than a month. The value of the exports of cutlery to the United States last year was only 52,710 dollars, as compared with 260,456 dollars in 1930. The heavy difference is largely owing to the decline of the trade in blanks for safety razor blades. Total exports of safety razors, blades, and blanks last year only amounted to 21,311 dollars, as against 214,425 dollars in 1930. A census of production in the cutlery trade, published in the *Board of Trade Journal*, shows that the value of the output of cutlery in 1930 amounted to £2,742,000, compared with £3,101,000 in 1924; and the average number of persons employed was 9021, compared with 9892. The figures are based on returns from 126 establishments employing more than ten operatives on the average. There was a substantial decline in the production of all classes of cutlery, except safety razors and blades, in which there was a large increase. The number of knives produced was down by more than 25 per cent. on 1924. There was a still greater decline, proportionately, in the production of scissors. The 1930 output was 103,000 dozens, value £80,000, as compared with 195,000 dozens, value £115,000, in 1924.

Industrial Developments.

Many inquiries are coming from foreign firms which are seeking factories or sites whereon to build, and it is reported from the London Chamber of Commerce that twenty Continental or American firms have already definitely decided to erect factories in this country. All this, of course, even if it has no direct bearing on Sheffield, is cheering to the steel trade, as steel for machine tools is sure to be wanted. One of the inquiries is of special interest to this district. It has been received from a firm of engineers in Switzerland, which requires a site extending to 25,000 square feet, with 10 acres of land adjoining for expansion. From Bradford it is reported that a German firm of die casters in the automobile industry is negotiating for land on which to establish a new industry that would employ 500 people, with prospects of very large developments. It is stated that the firm's materials will be required throughout this country, as a special alloy which they manufacture is not made here at present.

At Doncaster and Crowle.

One of the most important items with regard to industrial development in this district relates to Doncaster, where a large extension of the British Bemberg artificial silk factory is contemplated. It is understood to be the intention of the Bemberg headquarters in Germany to close a large factory in that country and to bring the principal machinery, which is of a highly specialised character, to Doncaster. The number of operatives at Doncaster is likely to be increased from the present 1000 to 6000. A number of highly skilled technicians will be sent from the Continent to instruct unskilled local labour. At Crowle, negotiations have been completed for setting up a new industry associated with the iron and steel trade. A considerable tonnage of ore will come in, to be sent away in a compressed form for use in the manufacture of iron and steel.

Successful Oil-Electric Railcar.

An oil-electric railway coach, which the L.N.E.R. Company intends to use on its summer services in the North of England, was given a trial on the steep gradients between Scarborough and Whitby last week, and proved satisfactory. Among the passengers were the chairman of the line and other directors, who wished to personally test the car, in view of its possibilities as an alternative to the electrification of the whole system. Built at Newcastle by Armstrong, Whitworth and Co., Ltd., it is of 250 H.P., and accommodates sixty passengers. The route covered is regarded officially as the most difficult stretch of line on the system because of its steep gradients, and the party travelled over them faster than any rail passenger has every done before. On the journey from York to Scarborough and back the average consumption rate is reported to have been 5 miles per gallon, giving a fuel cost of ¼d. per mile.

Midland Canal Improvements.

A project which promises to facilitate industrial progress in the Midlands is that of the Grand Union Canal Company for carrying out extensive improvements to the Leicester, Loughborough, and Erewash canals, which it took over on January 1st. The canals are to be dredged so as to admit of the passage of motor craft, and the existing narrow locks are to be widened. Firms in Leicestershire, Nottinghamshire, and along the Erewash valley in Derbyshire, engaged in coalmining, granite quarrying, ironfounding, and other industries, which depend for their prosperity upon cheap transport, are keenly interested in the projected improvements.

Electric Refuse Collection.

The profitable use to which refuse may be put is shown by the annual report of the cleansing department of Sheffield Corporation. During 1931 the refuse disposal works were able to supply cinders, screened from refuse, to all the public baths and wash-houses for steam-raising purposes, in addition to generating 1,121,204 units of electricity for operating and lighting the plant, and supplying current for charging the batteries of the eighty electrically-propelled refuse collecting vehicles. Two further dustless refuse collection vehicles, having larger containers than the first experimental petrol vehicle, were purchased last autumn. The new vehicles are propelled electrically and are the first of their kind to be used in this neighbourhood. The continuous replacement, over several years, of a certain type of battery by those at present used is now making itself felt, and justifies the changeover, as during the year the electric vehicle fleet travelled 13,129 more miles than during the previous year, but consumed 47,131 fewer units of electricity.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Trade Outlook.

THE general state of industry in the North of England possesses more unsatisfactory than satisfactory features. Usually at this time of the year, the tendency is towards improvement, but at the moment there are few signs of animation in any section of industry. Hopeful evidence of a little revival in the pig iron trade is, however, to be found in the fact that Dorman, Long and Co., Ltd., Middlesbrough, have this week put an additional blast-furnace into operation on the production of hematite pig iron at their Eston Works; but the industry is still in a sad plight. Only seventeen blast-furnaces are now in operation on the North-East Coast, whereas the pre-war figure was often as high as seventy, though output capacity was not then so heavy as now. A year ago the number of blast-furnaces in operation was twenty-five. The steel constructional trade provides one of the brightest features of the moment. Some of the works are fairly active. For instance, Dorman, Long and Co., Ltd., have still a number of useful contracts of that character on hand. The Lambeth Bridge, the Londonderry Bridge, the Putney Bridge, the Kasr-el-Nil Bridge, Egypt, and the Tees Bridge at Middlesbrough, are included in the firm's bridge undertakings. Another important branch of industry with Dorman, Long and Co., Ltd., is in connection with the contract for equipment for the South African Iron and Steel Industrial Corporation. One of the busiest firms in the district is the Cargo Fleet Iron Company, Ltd., one of the Furness Group units. The firm has capacity for more work, but has proportionately less idle plant than any other. In particular, the company has been successful in obtaining orders for rails and sleepers, and is still busy with such orders. Rails for all the principal companies in this country and for South Africa are being made by the firm. Other sections of the steel trade, however, are urgently in need of orders. The outlook in the coal trade is very doubtful, and it is difficult to tell what the conditions will be in a few weeks. Already there is lost time at some of the pits for want of trade, and, unless the demand shows more briskness, further idle days are likely to be experienced.

Cleveland Iron Trade.

Little interest seems to be displayed in the Cleveland pig iron market and current business is on a most disappointing scale. All manner of difficulties encompass the export trade, and home demand is limited owing to the industrial slackness. Nor is there any indication of better business in Scotland, where Midlands iron is underselling the Cleveland product by 2s. per ton, a small but sufficient margin to divert orders to the Midlands

area. Stocks, however, are still being drawn upon to meet requirements, and this enables ironmasters to take a firm stand as regards values. Prices are unchanged, No. 1 Cleveland foundry being 61s., No. 3 G.M.B. 58s. 6d., No. 4 foundry 57s. 6d., and No. 4 forge 57s.

Hematite Pig Iron.

Buyers of East Coast hematite pig iron state that they experience little difficulty in covering requirements on the basis of ordinary qualities at 64s. 6d., but producers protest that such terms are well below cost and are inclined to hold out for more, believing that quotations are likely to take an upward turn in the near future. Customers abroad are becoming more disposed to negotiate for supplies.

Ironmaking Materials.

Conditions in the foreign ore trade still do not admit of business of moment. The nominal price of best Rubio is 16s. 6d. c.i.f. Tees. Good medium blast-furnace coke is firm at 17s., delivered to consumers on the North-East Coast.

Manufactured Iron and Steel.

In the manufactured iron and steel trade there is a little more overseas inquiry, but shipments have fallen to a very low ebb and home buyers are only purchasing on a very limited scale. The sheet trade is somewhat firmer and £9 5s. per ton is now a minimum for galvanised corrugated sheets; but all other quotations are unaltered.

The Coal Trade.

It is a long time since the Northern coal trade position presented such a dull appearance as it does just now, and it is not easy to guarantee a good forward position. In every class of coal, inquiry is reported to be totally absent, while bookings on hand are small. For prompt the shipment is fairly good as tonnage has arrived freely; but that supply will be rapidly cleared, and with the general lack of demand for additional early loading tonnage, coalowners are faced with a dull period. Every description of coal is affected. Shipments are restricted by the French surtax and the increased Italian import duties. The financial stringency in some countries also helps to reduce the flow of orders. Devalued sterling has given English coal an advantage at German coastal towns, and although reductions have been made by the German railways on coal freights, the reductions are said to be insufficient to meet the depreciation of the pound. The quota, of course, affects shipments generally, while continued mild weather enables household consumers to keep consumption down. Factories abroad are all working under difficult conditions, and large numbers are actually idle; thus, the commercial demands are restricted. There is no scarcity of any class of Northumberland steam coal. Best qualities are quoted at 13s. 9d., but meet with little interest from shippers. This class is about the only grade of Northern coal held for values above the schedule minimum. Tyne prime and Northumberland seconds can be readily obtained at 13s. and 12s. respectively, and for any quality of steam small, prices are at the lowest figures, the best class being 8s. 6d. Considerable idle time is being experienced at many of the Durham centres, and under present conditions the prospects are that several will be laid totally idle. There is no pressure for any quality, and prices are weakly maintained. Best gas coals are quoted at 14s. 6d., and second qualities at 13s. 6d. Coking unscreened is in quiet demand at 13s. to 13s. 6d., and coking small 12s. 6d. to 13s. Favourite bunker qualities can be bought as low as 14s. to 14s. 3d., and good ordinary at 13s. Gas coke is scarce for prompt and readily commands 19s. Coke nuts are now in request for February shipment and quoted steady at 19s. to 21s. Patent oven coke is plentiful and moving slowly at easy prices of 16s. 6d. to 17s. Superior foundry coke is steady at 18s. to 21s.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding.

THE firm of William Denny and Bros., Ltd., has recorded the first launch on the Clyde this year. On Monday last the L.M.S. steamer "Slieve More" left the stocks in the Dumbarton yard. During the proceedings Mr. Maurice Denny said that, a few days prior to the launch of the "Slieve More," it appeared as though the Dumbarton yard would be left with empty berths, but an order from the Southern Railway Company had relieved the situation in that respect. Incidentally, that ship was the first order received on the Clyde this year. Orders for repair work have, however, not been quite so scarce. Vessels have been docked at Meadowside and Linthouse, and it is just announced that Alexander Stephen and Sons, Ltd., of Linthouse, have booked an important order for repair work which includes extensive boiler, machinery and structural alterations. Barclay Curle and Co., Ltd., Harland and Wolff, Ltd., and the Blythswood Shipbuilding Company, Ltd., also have several repair contracts on hand.

Steel.

The prevailing note in the steel industry is one of extreme dullness. Export inquiries are moderate, but tonnages are small, while home requirements are exceedingly small. Demands for heavy steel are restricted, sections and plates being poorly specified.

Steel Sheets.

Black sheets have a fairly steady turnover, particularly in special qualities. Business in galvanised descriptions is rather irregular, but prices show no movement.

Iron.

The recent reduction in the price of bar iron has not proved beneficial, orders being as scarce as ever. Re-rolled steel also is in a most unsatisfactory position. Keen prices have to be quoted to obtain even a small proportion of the business being offered, and, with billets on a dearer level, it appears difficult to avoid loss. Re-rolled steel bars are quoted £6 5s. home and £6 2s. 6d. per ton export.

Pig Iron.

The pig iron market continues without any outstanding feature. Only five furnaces are in blast, but stocks are ample.

Scrap.

The market for scrap is restricted, but prices are comparatively firm at 57s. 6d. to 60s. for cast iron machinery, 42s. 6d. heavy steel, and about 38s. per ton heavy basic.

Coal.

There is no sign of an improving tendency in the Scottish coal trade. Foreign demands are most limited, owing to weather conditions, restricted foreign exchange facilities, and increased import duties. The turnover, as a rule, is for prompt despatch, shippers being disinclined to consider anything in the nature of speculative business. Steam coals are easily obtained and prices tend easier, and the same applies to washed materials. Lanarkshire splint coal supplies the exception to the general rule, being fully booked to the end of this month and fairly well sold for February loading. Business in the home market is dull owing to quiet industrial conditions and continued mild weather. Supplies are plentiful and collieries have been unable to obtain the usual seasonal advances in price.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

CONDITIONS in the steam coal section of the industry have again been very quiet during the past week, and although the figures relating to shipments issued by the G.W.R. Company for the week ended the 23rd inst. show a welcome improvement upon those for the preceding week, there is no certainty that the higher level of activity will be maintained. The total for the six ports under the control of the G.W.R. Company was 477,430 tons, which compared with 375,925 tons for the preceding week, and with 303,002 tons for the corresponding period of last year. As a matter of fact, the quantity for the week ended the 23rd inst. was the highest since the week ended December 19th last, and, in a large measure, was due to tonnage, which had been considerably delayed by bad weather, arriving, and thus placing collieries in a better position, at least temporarily. At the end of last week the number of vacant loading berths was still thirty-one, but as the result of arrivals over the week-end the situation on Monday was that the number of vacant berths was reduced to thirteen, so that collieries were able to make a very fair start, but the trouble is that there is not a great deal of tonnage to follow on, and business for early loading is unquestionably quiet. Chartering operations have been below the normal, and it is not an exaggeration to state that many owners have scarcely been able to find an outward freight for their steamers, and rates have remained at the very lowest levels. The plight of the coal industry generally has very naturally been the subject of the addresses of the new Presidents of the Swansea and Newport Chambers of Commerce, and both of them—Mr. D. Emlyn Rees and Mr. T. Bert Price respectively—and Mr. W. D. Wight—Chairman of the South Wales Coalowners' Association—who spoke at the annual dinner of the South Wales Institute of Engineers, criticised pretty strongly the provisions of the Coal Mines Act, particularly Part I., which deals with the marketing side of the industry. It is, of course, well known that the Government is interested in finding out what are the views of the industry generally upon the question, as it will be compelled to introduce legislation in the course of the next few months to deal with the matter of working hours, since the period fixed for the continuance of the 7½-hours' shift comes to an end on July 8th. Colliery undertakings in this area have received from the Executive Board of the South Wales District Marketing Association a questionnaire in order to ascertain from them individually their views on the advisability of continuing in its present or modified form Part I. of the Coal Mines Act. It will be interesting to see what the result will be, as up to now it has been common knowledge that there is a strong divergence of opinion among the coalowners in South Wales.

Bristol Channel Despatch.

Reference was made recently to the complaints of local shipowners of the delays suffered by steamers loading in South Wales ports compared with the work done on vessels in the Tyne. Since then, instances have been forthcoming of steamers getting loaded in very satisfactory time in this area, thus showing that the work can be done with expedition. The point is, that arrangements should be made so that quick loading can always be secured, and a step towards that end was arrived at on Monday when there was a meeting at Cardiff of the Trimming Board. The employers' representatives then intimated to the trimmers' representatives that proposals would be placed before the men's executive by Monday next for their consideration, but the nature of the proposals has not yet been divulged. As soon as the men's executive has had time to consider them, there will be a joint meeting with the employers' representatives to go into the matter.

New Industries.

For some time past all the leading towns in South Wales have been conducting a strong agitation for attracting new industries to their midst, and each has been setting forth its special advantages, but, although there has been much talk, there is extremely little evidence of successful accomplishment. Professor H. A. Marquand, who is the first holder of the Chair of Industrial Relations at Cardiff University College, in dealing with the problem of new industries, has strongly advocated the establishment of a regional council covering the whole of this area for the purposes of development. This suggestion has only met with qualified support, which was only to be expected in view of the keen competition existing between the leading towns. However, the Lord Mayor of Cardiff has expressed himself as ready to call a conference of South Wales public authorities, industrialists, trade union leaders, and others to consider the situation, and there appears to be a readiness on the part of all interested in the question to attend this conference and see what can be done.

Tin-plate Items.

The ascertainment which governs the wages of the lower-paid workmen in the Welsh tin-plate industry shows that for the quarter ending April 30th next there will be no variation in pay. The net selling price of tin-plates, after various deductions, results so that no bonus will come to the workmen under the sliding scale agreement. The question of control of the tin-plate industry was referred to by Mr. Frank Rees, who last week was re-elected President of the Swansea Metal Exchange. After dealing with the inter-dependency of the steel, sheet, and tin-plate industries, he said that attempts were once more being made to organise afresh a pool or quota system in the tin-plate trade. Without in any way prejudging the proposals as such, he expressed the hope that out of the chaos in which the industry found itself it would be possible to arrive at some order as the result of the adoption of a co-operative scheme. He, however, uttered a word of warning. Co-operative schemes which did not include 100 per cent. of the industry could never be wholly satisfactory, because it was the few that remained outside who would contribute most towards instability and depression of price levels.

Colliery Disaster.

The Rhondda has this week been cast into a state of gloom by the news of disaster at the Llwynypia No. 1 Colliery. It was about 6.30 on Monday night that an explosion of firedamp took place in the Pentre Seam, and as a result nine persons lost their lives, four as the direct result of the explosion and five from the effects of after-damp. Two of the rescuers were also overcome by after-damp, and succumbed, thus bringing the death-roll to a total of eleven. All the bodies were recovered and brought to the surface, and an official statement shows that the ventilation has been fully restored and the whole of the workings visited. The cause of the disaster is not known, but all through Monday night the most heroic efforts were made by all, from the manager of the collieries—Mr. H. H. Evans—to the lowest grade of workman, to assist those who were unfortunate enough to be in the pit at the time of the accident.

North Wales Coalfield Audit.

The North Wales coalfield audit for November shows a debit balance of £3724, equal to 3·45d. per ton on an output of 258,831 tons, and for the three months ended November a debit balance of £3188, or 0·96d. per ton. The proceeds at pithead in November averaged 12s. 10·71d. and for the three months ended November 12s. 10·12d., while the costs of production were respectively 13s. 2·16d. and 12s. 11·08d. The wage certified in accordance with the wages agreement was 1·10 per cent. above the basis rate, but the agreement also provides for a minimum wage rate of 22 per cent. above the basis rate, and in the payment of this minimum there was incurred a deficiency of £71,362, thus bringing the deficiency carried forward to £4,506,722.

Current Business.

Business has been very slow, and there is continued evidence that foreign consumers are only purchasing on a hand-to-mouth principle. Fresh orders come along on meagre lines, and are wholly insufficient to infuse any life into the market. Collieries as a consequence have the greatest difficulty to find an outlet for their production, and work at numerous pits is only on an intermittent scale. All grades of coal are obtainable without difficulty, and prices remain at the minima. Coke moves off rather slowly, and the fresh demand for patent fuel is quiet. Pitwood meets with a moderate demand at round about recent prices.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

WE are asked to state that Plenty and Son, Ltd., marine engineers, Newbury, are in no way connected with the firm of Plenty-Still Oil Engines, Ltd., of Kings-road, Newbury.

JAMES HOWDEN AND CO. (LAND), Ltd., of Caxton House, Westminster, London, S.W. 1, ask us to announce that they have reopened their Manchester office, at Romiley, Bramhall-lane, Bramhall, Stockport. Mr. C. E. H. Eckersley, previously attached to the head office in London, is the manager in charge of the Manchester district, which covers Cheshire, Lancashire, Yorkshire and the North of England.

THE CARGO FLEET IRON COMPANY, Ltd., asks us to announce that from to-day the London Office of the Furness Group of Companies, comprising The Cargo Fleet Iron Company, Ltd., The South Durham Steel and Iron Company, Ltd., and Cochrane and Co., Ltd., will be 21, Tothill-street, Westminster, S.W. 1. The telephone number and telegraphic address will remain as before, namely, Victoria 9791, and Carfieco, Sowest, London, respectively.

CONTRACTS.

THE GENERAL ELECTRIC COMPANY, Ltd., has received an order from the Bury St. Edmunds Corporation for over 25,000 Pearl Osram lamps, which are for use in connection with the "change over" from D.C. to A.C. supply.

THE WESTINGHOUSE BRAKE AND SAXBY SIGNAL COMPANY, Ltd., has received an order to supply the brake sets required for a further ten wagons ordered from the Metropolitan-Cammell Carriage, Wagon and Finance Company, Ltd., by the Chinese Government Purchasing Commission.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	16/– to 19/6
(1) Spanish	17/– to 21/–
N.E. COAST—	
Native	18/– to 21/–
Foreign (c.i.f.)	16/6 to 17/–

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 8 6	—
No. 1 Foundry	3 12 0	—
No. 3 Foundry	3 9 6	—
N.E. COAST—		
Hematite Mixed Nos.	3 4 6	3 4 6
No. 1	3 5 0	3 5 0
Cleveland—		
No. 1	3 1 0	3 1 0
Siliceous Iron	3 1 0	3 1 0
No. 3 G.M.B.	2 18 6	2 18 6
No. 4 Foundry	2 17 6	2 17 6
No. 4 Forge	2 17 0	2 17 0
Mottled	2 16 6	2 16 6
White	2 16 6	2 16 6
MIDLANDS—		
(c) Staffs.—	(*Delivered to Station*).	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 1 0	—
" " Foundry	3 6 0	—
(c) Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
(c) Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. COAST— N. Lancs. and Cum.—		
Hematite Mixed Nos.	3 15 6 (a); 4 0 6 (b); 4 5 6 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	9 15 0	9 5 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 5 0	—
Common Bars	10 10 0	—
Best Bars	11 0 0	—
Double Best Bars	11 10 0	—
Treble Best Bars	12 0 0	—
LANCS.—		
Crown Bars	9 15 0	—
Second Quality Bars	8 5 0	—
Hoops	12 0 0	—
S. YORKS.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	9 5 0 to 10 7 6	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 7 6	—
Gas Tube Strip	10 10 0 to 10 12 6	—

STEEL. (d)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates (Marine)	9 0 0	8 10 0
" " (Land)	—	—
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	7 10 0	7 10 0
Sheets (Gal. Cor. 24 B.G.	10 5 0	9 10 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
" " (Land)	10 0 0	—
Joists	8 15 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 10 0 to 9 0 0	—
MANCHESTER—		
Bars (Round)	9 7 6	—
" (Small Round)	7 0 0	—
Hoops (Baling)	10 0 0	9 15 0
" (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
" (Lancs. Boiler)	8 15 0	—
SHEFFIELD—		
Siemens Acid Billets	9 2 6 (basis)	—
Hard Basic	8 2 6 and 8 12 6	—
Intermediate Basic	6 12 6 and 7 2 6	—
Soft Basic	6 0 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	7 10 0	—
MIDLANDS—		
Small Rolled Bars (all British)	7 15 0 to 8 0 0	—
Small Re-rolled Bars	6 17 6 to 7 0 0	—
Billets and Sheet Bars	5 7 6 to 5 10 0	—
Galv. Sheets, f.o.b. L'pool	9 5 0 to 9 7 6	—
(2) Staffordshire Hoops	9 10 0	—
(d) Angles	8 7 6	—
(d) Joists	8 15 0	—
(d) Tees	9 7 6	—
(d) Bridge and Tank Plates	8 17 6	—
Boiler Plates	8 12 6	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14 f.o.b.	14/3 to 14/9
Block Tin (cash)	140 5 0
" (three months)	143 5 0
Copper (cash)	39 0 0
" (three months)	39 2 6
Spanish Lead (cash)	14 18 9
" " (three months)	15 0 0
Spelter (cash)	14 8 9
" (three months)	14 16 3
MANCHESTER—	
Copper, Best Selected Ingots	42 15 0
" Electrolytic	47 10 0
" Strong Sheets	77 0 0
" Tubes (Basis Price), lb.	0 0 11
Brass Tubes (Basis Price), lb.	0 0 10
" Condenser, lb.	0 1 0½
Lead, English	16 7 6
" Foreign	15 0 0
Spelter	14 17 6
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/4 per lb.	
Ferro Tungsten	2/– per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24 12 6	7/–
" " 6 p.c. to 8 p.c.	£23 10 0	7/–
" " 8 p.c. to 10 p.c.	£22 15 0	6/6
" " Specially Refined		
" " Max. 2 p.c. carbon	£36 10 0	10/–
" " " 1 p.c. carbon	£43 10 0	12 –
" " " 0·70 p.c. carbon	£52 10 0	13/–
" " " carbon free	11d. per lb.	
Metallic Chromium	3/1 per lb.	
Ferro Manganese (per ton)	£11 0 0 for home	
" " "	£11 10 0 for export	
" Silicon, 45 p.c. to 50 p.c.	£9 15 0 scale 5/– per unit	
" " 75 p.c.	£15 10 0 scale 7/– per unit	
" Vanadium	12/9 per lb.	
" Molybdenum	6/3 per lb.	
" Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£250 to £255	
Ferro Cobalt	10/– per lb.	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	13/– to 13/3
" " Ell	14/– to 14/3
" " Splint	14/3 to 16/–
" " Trebles	15/–
" " Doubles	12/9
" " Singles	10/–
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/6
" " Jewel	17/–
" " Trebles	15/–
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	12/6 to 13/9
Screened Navigation	17/–
Trebles	14/6
Doubles	12/6
Singles	10/–
LOTHIANS—	
(f.o.b. Leith)—Best Steam	12/9
Secondary Steam	12/3
Trebles	14/6
Doubles	12/6
Singles	10/–

(8) N.W. COAST— ENGLAND.

Steams	21/9
Household	32/6 to 51/8
Coke	20/– to 21/6
NORTHUMBERLAND—	
Best Steams	13/9
Second Steams	12/3 to 12/6
Steam Smalls	8/6 to 9/–
Unscreened	12/6 to 13/–
Household	27/– to 39/–
DURHAM—	
Best Gas	14/6
Second	13/6
Household	35/– to 37/–
Foundry Coke	24/–

SHEFFIELD—	Inland.	
Best Hand-picked Branch	26/– to 27/–	—
South Yorkshire Best	24/– to 25/–	—
Derbyshire Best Bright House	20/6 to 21/6	—
Best House Coal	22/– to 23/–	—
Screened House Coal	19/– to 20/6	—
Best Screened Nuts	17/– to 18/–	—
Small Screened Nuts	15/6 to 16/6	—
Yorkshire Hards	17/– to 18/6	—
Derbyshire Hards	17/– to 18/6	—
Rough Slacks	9/– to 10/–	—
Nutty Slacks	8/– to 9/–	—
Smalls	5/6 to 6/6	—
Blast-furnace Coke (Inland)	12/– to 12/6 on rail at ovens	
Furnace and Foundry Coke (Export), f.o.b., 18/– to 18/6		

(9) SOUTH WALES.

CARDIFF—	
Steam Coals :	
Best Smokeless Large	19/6 to 19/9
Second Smokeless Large	18/9 to 19/6
Best Dry Large	19/– to 19/6
Ordinary Dry Large	17/9 to 18/3
Best Black Vein Large	18/3 to 18/6
Western Valley Large	17/9 to 18/–
Best Eastern Valley Large	17/7½ to 17/9
Ordinary Eastern Valley Large	17/3 to 17/6
Best Steam Smalls	13/– to 13/6
Ordinary Smalls	11/– to 13/–
Washed Nuts	19/– to 27/–
No. 3 Rhondda Large	19/9 to 20/–
" " Smalls	15/– to 16/–
No. 2 " Large	17/– to 17/3
" " Through	15/6 to 16/–
" " Smalls	14/– to 14/3
Foundry Coke (Export)	22/6 to 36/6
Furnace Coke (Export)	17/– to 18/–
Patent Fuel	19/– to 19/3
Pitwood (ex ship)	23/– to 24/6
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	36/– to 38/6
Seconds	27/– to 32/6
Red Vein	22/6 to 27/6
Machine-made Cobbles	41/6 to 48/6
Nuts	40/– to 48/6
Beans	28/6 to 32/6
Peas	19/– to 21/–
Breaker Duff	8/6 to 9/6
Rubbly Culm	8/3 to 8/9
Steam Coals :	
Large	20/– to 20/6
Seconds	18/– to 20/–
Smalls	11/6 to 13/–
Cargo Through	16/– to 17/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham. (d) Rebate; Joists (minimum), 22/6; Ordinary Ship, Bridge, and Tank Plates and Sections, 15/– if home consumers confine purchases from associated British Steel Makers. (e) Delivered Black Country Stations.

French Engineering Notes.

(From our own Correspondent in Paris.)

The Steel Situation.

THE idea formerly entertained that France is, to a large extent, self-supporting and is less dependent on foreign trade than other countries, has been modified by the dwindling of exports which has affected all branches of industry, is increasing unemployment, and leaving manufacturers seriously anxious as to what will happen in the future. The national steel pact, recently signed, will ensure, with the aid of import quotas of iron and steel products, that manufacturers will supply practically all that is required at home and in the Colonies, and that will necessarily mean a restricted production for a long while to come. Those requirements are not large, nor are they likely to be until all the big enterprises are put in hand, and there is little probability of that being done at an early date now that the possible suppression of German reparations may deprive the country of resources upon which it has relied. The building of the Trans-Saharan railway, in particular, was largely dependent upon the aid which Germany would have rendered under the reparation agreement. Moreover, it is hardly conceivable that the national pact will be allowed to operate under cover of an exclusion of foreign products, which must be introduced as a means of preventing an undue inflation of prices on the home market; but the import quotas will be adjusted strictly to what is necessary to preserve a normal supply of iron and steel at a fair level of prices. This internal organisation of the steel trade rather complicates the already difficult negotiations for the international Steel Cartel, which interests, more particularly, exporting countries, and, if national pacts close markets to foreign iron and steel, its only object will be to divide up business in neutral markets and maintain prices. The chief exporting countries, like Belgium, will have little interest in the Cartel unless all markets are more or less open to them. Therefore, the only satisfactory basis of a stable organisation lies in the national pacts working with the Steel Cartel in the way of arranging for liberal quotas of iron and steel and thereby facilitating exchanges in the interests of all concerned. Already, the organisation of the steel trade, which has begun with the French steel-makers' pact and the negotiations for the reconstruction of the international sales comptoir, is creating some confidence.

State Orders.

Manufacturers are now calling upon the State to adopt vigorous measures to enable them to tide over the present critical period. All that can be hoped for is that the State and public bodies will provide enough employment to prevent the closing down of works, and, during the past week, tenders have been submitted for contracts in connection with the programme of national works, which include improvements and extensions at all the ports, while the railway companies will distribute orders for rolling stock as soon as they are authorised to raise money for the purpose. Further orders are being given out in connection with the big liner at Saint-Nazaire, and the continuance of the programme of naval construction will be an appreciable help to trade. The volume of work to be put in hand will be fairly considerable, but it will be wholly inadequate for the engineering trades in view of the absence of all private enterprise. The withdrawal of credit facilities is a further element of danger in the situation. The low prices being submitted for contracts which, it is declared, leave, in some cases, no profit at all, form another unsatisfactory feature, and it is clear that a subsequent reduction in costs which can hardly be effected with the already low prices of raw material, is implied, and makers must therefore look for economies in production and to lower wages, that appearing to be inevitable in view of the lower wages and costs in other Continental countries. Even the price of coal will have to come down. The Government refused the miners' request to reduce still further the import quotas of coal as a means of preventing a reduction of wages, and the coalowners have renewed the plea, which is now under consideration by the Government; but it is understood that if the quotas are reduced it will only be on the understanding that coalowners in the Nord and the Pas de Calais will lower their prices. In this connection, it is worth noting that exporters of pitwood from the Landes have experienced such a heavy slump in the consignments of pit props to Great Britain that they have appealed to the Government to provide further facilities for their export trade. So long as British colliers were able to deliver coal to Bordeaux they returned with pit props, and since the partial embargo on British coal, pitwood exporters have been deprived of those exceptionally low freights.

Hydro-electric Peak Load Supply.

The Paris electricity supply from Gennevilliers and other heat power stations is connected with the hydro electric supplies of Eguzon and Marèges in the Corrèze by a 220,000-volt line capable of carrying 100,000 kW, a capacity to be doubled in the near future by another main which will be extended to Brommat, in the Aveyron. In order to deal with peak loads, a scheme is now under consideration for creating two lakes of 3750 acres with a difference of altitude of 28 m. One will be made probably at Jargeau, in the Val de Loire, and the other in the Sologne. Pumping and turbo-alternator plants will be installed between the two lakes and connected with the transformer station at Chaigny, near Orleans. The lower lake will be filled from the Loire, and, for a number of hours during the day, surplus energy from the Eguzon supply will be utilised to pump the water to the upper lake. During times of heavy demand the water will be returned to the lower lake through turbines. The undertaking would be costly, but it is regarded as necessary in order to ensure a regular distribution to Paris as well as to the Paris-Orleans railway system. It may be remarked that this company continues to improve its steam locomotive service, and has run one of the twenty "Pacific" locomotives, now being modified for high-pressure steam, between Paris and Nantes, a distance of 263·8 miles, in 4 hours 20 minutes with a load of 500 tons.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patents Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

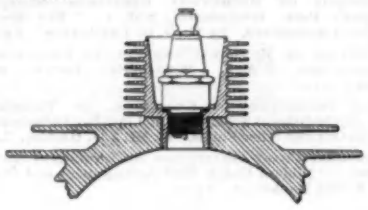
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

363,201. January 29th, 1931.—COOLING DEVICES, The Wright Aeronautical Corporation, Paterson, New Jersey.

The inventors state that it is common for the cylinder walls

Nº363,201



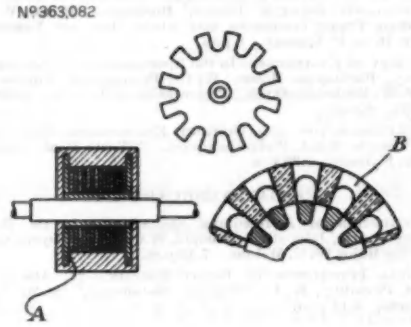
of air-cooled aero-engines to become overheated in the vicinity of the sparking plug. As a consequence, they provide a finned envelope for the plug made of a metal of high thermal conductivity, as shown in the drawing.—*December 17th*, 1931.

DYNAMOS AND MOTORS.

363,082. November 10th, 1930.—SQUIRREL-CAGE ROTORS FOR SMALL ELECTRIC MOTORS, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

In accordance with this invention, the conductors of very small squirrel-cage motors are electrically deposited in the slots which, as shown in the upper drawing, are open. Before depositing the winding material, end plates A are attached to the core, and

Nº363,082



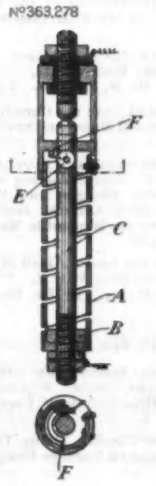
after deposition the excess copper is removed by turning. The parts which are to remain free from copper are covered with insulating material, and an oiled cord may be drawn into the bore of the hub. In order to prevent unnecessary deposition of the copper on the tops of the teeth, they may be covered with insulating material, such as a layer of grease or an insulated sleeve B with perforations may be slipped over the coil.—*December 17th*, 1931.

SWITCHGEAR.

363,278. May 18th, 1931.—THERMAL SWITCHES, Aktiebolaget Birka Regulator, of Surbrunnsgatan 48, Stockholm, Sweden.

This invention relates particularly to thermal switches, which, for the purpose of increasing the efficiency of the heat sensitive members, are enclosed in evacuated receptacles of glass, or in such receptacles filled with an inert gas. In such enclosed thermal switches it is of particular importance to obtain a rapid contact movement at the moment of opening, and especially at the moment of closing the contacts. According to the invention, when heated the member A is deformed in such a way that its outer end, together with the plate B and the rod C, is subjected to a turning force about the axis of the heat sensitive member. The roller of the abutment E then runs up on the inclined cam surface F, which has such a slope that the rod C, in addition to the turning movement, obtains a comparatively large axial movement in an outward direction, whereby the contact is rapidly broken. Upon a subsequent cooling, the outer end of the heat sensitive member is turned in the opposite direction, causing the abutment to slide down the cam surface F, whereby the contact rods are powerfully pressed against each other under the influence of the spring pressure. Thermal switches constructed according to the invention may be made with comparatively small dimensions, and especially with small transverse dimensions, and are particularly advantageous when the thermal switch is intended to be enclosed in an evacuated glass receptacle or in a glass receptacle filled with an inert gas.—*December 17th*, 1931.

Nº363,278



TRANSMISSION OF POWER.

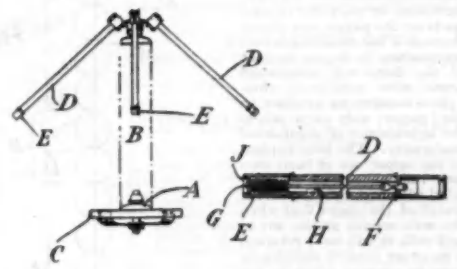
362,681. December 16th, 1930.—HIGH-TENSION ELECTRIC CABLES, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

Hitherto it has generally been customary to despatch and lay oil-filled high-tension cables provided with longitudinal oil channels or cavities inside the cable without the oil channels being filled with oil, and not until after the cable had been laid was the filling of the channels with oil proceeded with. According to the invention, when pressing the lead sheath on to the cable the sheath is made longer than the core of the cable, so that a sufficiently long piece, for example, 1 m. or 2 m. of lead pipe, projects beyond the core of the cable, whilst in this lead pipe there are arranged a sufficient number of oil compensating chambers, which preferably comprise corrugated tubes and are subjected either to atmospheric pressure or to a certain higher pressure. The cable, including the projecting part of the lead sheath, is then filled completely with oil and the lead tube is closed in an oil-tight and pressure-proof manner by pressing flat the open end and soldering or by covering the open end of the lead tube with a cap which is soldered on or screw-threaded in the lead pipe. In this way the compensating chambers keep the cable in all parts impregnated in a satisfactory manner at all temperatures until the cable is connected to the suitable feeder or pressure tanks. The projecting lead pipe containing the compensating chamber is then removed and the cable end prepared for jointing.—*December 10th*, 1931.

362,962. September 3rd, 1930.—PROTECTIVE DEVICES FOR TRANSMISSION LINES, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2.*

The protective device described in this specification is for use in connection with high-tension transmission lines for the purpose of protecting strings of insulators against damage resulting from arcing or flash-over. The position occupied by a string of insulators comprising any desired number of units A is indicated at B. Mounted at the lower end of the string is an electrode in the form of an electrically conducting grading ring C. Fuses D, mounted at the upper end of the string B, serve as electrodes or arcing members. Each fuse is of the expulsion type. When for any reason, as in the event of

Nº362,962



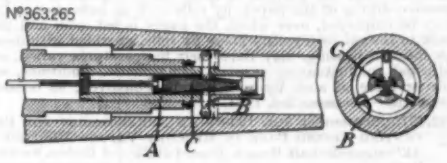
lightning, there is a sudden surge along the line tending to produce a flash-over, an arc will jump between the ferrule E of one of the fuses and the grading ring C. When this takes place the flow of current through the link F will cause it to melt and break, thereby releasing the pressure of the spring G, and causing the resistance unit H, spring and cap J to be expelled, thereby driving away the arc and preventing it from continuing, with the resultant interruption to service. In the event of a subsequent arc another of the fuses will be blown. Naturally, inspection along the line must be and is made from time to time, and it can then be readily ascertained which, if any, of the fuses have been blown, and those that have been blown are, of course, replaced by new fuses.—*December 3rd*, 1931.

ORDNANCE AND ARMOUR.

363,265. April 16th, 1931.—MOUNTING LINERS IN GUN TUBES, Schneider et Cie., 42, Rue d'Anjou, Paris, France.

In inserting the liner into a gun with a stepped bore, it is generally difficult to ensure that they are co-axial, with the result that the liner may be damaged in being pressed into

Nº363,265



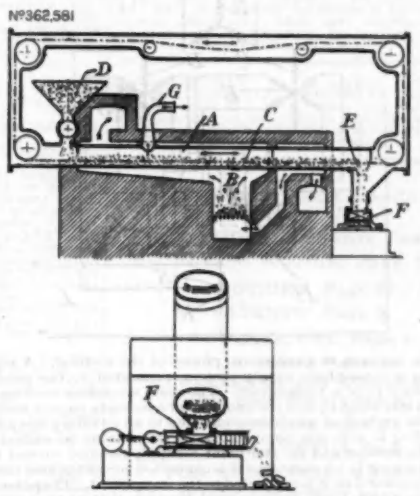
place. The inventors consequently guide the front end of the liner by the device illustrated. It comprises a socket A, which is fitted in the mouth of the liner, and is equipped with three arms B, having rollers to engage with the bore of the gun. These arms can be adjusted to the diameters of the various steps by means of the wedge and screwed rod C.—*December 17th*, 1931.

GAS PRODUCERS.

362,581. October 6th, 1930.—LOW-TEMPERATURE DISTILLATION OF COAL, H. Steven, 60, rue Alfred Becquet, Namur, Belgium.

In this process the coal is treated at a temperature from

Nº362,581



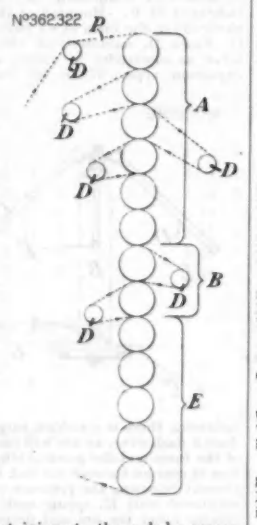
420 to 500 deg. Cent. under a vacuum of about half an atmosphere. The retort A is horizontal and is heated by the furnace B. Through it passes a scraper conveyor C, which is totally encased to exclude the atmosphere. Raw coal is fed on to the conveyor

from the hopper D through a reciprocating feed device, which makes a practically air-tight seal. The semi-coke produced by the process drops through the conveyor at E and is pushed out by another air-tight reciprocator F. The gaseous products of distillation are drawn off at G.—*December 10th*, 1931.

MISCELLANEOUS.

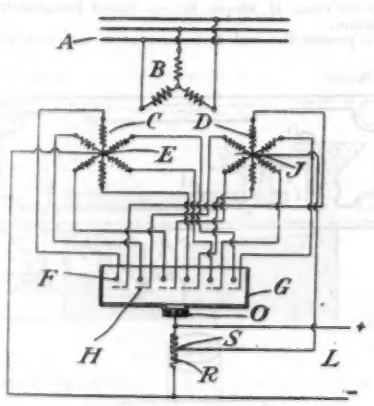
362,322. May 14th, 1931.—MANUFACTURE OF TRANSPARENT PAPER, S. D. Warren Company, 89, Broad-street, Boston, Massachusetts.

The inventors' method of transparentising paper is as follows: The paper web indicated by P on the accompanying drawing, after having been initially dried, is moistened with water containing preferably not more than 8 per cent. of glycerine—for which a glycol, mannitol, or the like may be substituted as an equivalent—the moisture content of the paper being brought to about 30 per cent. water on the dried paper weight. This paper enters the calender at the top, passing in succession between the hard steel surfaces of the upper set A of hard rolls. This treatment between hard unyielding surfaces condenses the body of the paper web, smooths it and enhances its transparency; but inevitably, for the reasons above indicated, the densely compacted areas do not extend over the entire paper web, irregularly distributed portions of the paper web have escaped the full effect of condensation and smoothing, and were the paper to be withdrawn in this condition its physical irregularities would be too apparent. This defective condition is corrected by the operation of the midway series of soft rolls B, between which the paper web passes after leaving the upper set of hard rolls. The deformability of the superficial portions of the soft rolls enables them to reach with effective compression and smoothing action the hitherto untreated or partially treated spots on the paper, and effects thereon a condensation which approaches in degree to that of the hard roll condensed areas with sufficiently close approximation to produce in the paper web as a whole the appearance of substantial uniformity. The heat applied to the upper set of hard surface rolls should be so regulated with regard to the rate of travel of the paper that when the web arrives at the set of soft rolls it will have retained a moisture content sufficiently large to prevent injury to the web by the soft rolls which grip the web a little more firmly than the hard rolls. This protective water content should be of the order of 10 per cent. to 12 per cent. on dried paper weight. This has been found effective to guard against injury to the web by reason of the slight differential slip between the frictionally driven rolls. When the soft roll treatment of the paper is completed it is necessary to carry the extraction of water by drying to that minimum percentage which is essential to preserve proper mechanical strength in the finished paper product. This final extraction of moisture must be accompanied by continued roll pressure, otherwise the paper is liable to cockle and be injured in quality by the formation of voids on the evaporation of water. The inventors therefore conduct the paper web from the set of soft rolls through the lower set E of hard rolls, which are so heated that when the paper is delivered from the calender it will contain about 6 per cent. or 7 per cent. of water. This water content conserves the strength of the paper, which is quite tough enough to be safely manipulated in a folding and wrapping machine. For the purpose of more nicely regulating the progressive drying of the paper, fly rolls such as indicated at D D may be employed, over which the paper is led from and then back to the calender rolls. These fly rolls, provided with means for internal heating, may have their temperatures varied, and adjusted to fluctuating external atmospheric conditions, and one or more of such fly rolls can be employed, as occasion demands.—*December 3rd*, 1931.



362,931. September 5th, 1930.—AN ARRANGEMENT FOR PREVENTING ARCING BACK IN MERCURY VAPOUR RECTIFIERS, Aktiengesellschaft Brown, Boveri et Cie., of Baden, Switzerland.

According to this invention arcing back in mercury vapour rectifiers is avoided by giving the star point of an auxiliary winding on the transformer a potential which is equal to or higher than the potential of the star point of the secondary winding of the transformer, feeding the rectifier, but lower than the potential of the cathode, the phase of the controlling voltage applied to the grid preferably being in advance of the phase of the corresponding anode voltage by an angle which is smaller than the



angle between two successive phases of the rectifier. A represents a three-phase supply system, connected to the primary winding B of a transformer. The main secondary windings C, with star point E, feed the anodes F of a mercury vapour rectifier G, the grids H of which are connected to an auxiliary secondary winding D with star point J. Leads taken from the cathode O of the rectifier and the star point E supply rectified current to a load circuit L. A resistance R is connected across the load circuit and a point S on it is connected to the star point J. The potential of the point J will be in general between that of the cathode O and the point E. The potential of each grid is controlled so as to be in advance of the potential of its corresponding anode by the angle between two successive phases of the rectifier.—*December 7th*, 1931.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Tuesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY.—At the Comedy Restaurant, Panton-street, Haymarket, W. 1. Annual Dinner and Dance. 7.30 p.m. for 8 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—Electrical Engineering Theatre, Armstrong College, Newcastle-upon-Tyne, North-Eastern Students' Section. Students' Lecture, "Switchgear," by Dr. C. C. Garrard. 7.15 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, Westminster, S.W. 1. "The Mechanism of Electric Locomotives," by Mr. J. D. Twinberrow. 6 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—84, Eccleston-square, S.W. 1. Metropolitan District meeting. 6.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "Centrifugal Separation of Liquids—Industrial Applications to Oils and other Fluids," by Mr. J. J. Haslam. 7.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—"Modern Dutch Yard Arrangement and Practice," by Mr. A. Van Donkelaar. 6 p.m.

MONDAY, FEBRUARY 1ST.

BRADFORD ENGINEERING SOCIETY.—At the Technical College, Great Harton-road, Bradford. "The Modern Aircraft Engine," by Major B. W. Shilson. 7.30 p.m.

ENGINEERS' GERMAN CIRCLE.—At the Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. Inaugural Meeting. 6 p.m. For details see page 129.

INSTITUTE OF FUEL.—At the Institution of Electrical Engineers, Victoria Embankment, W.C. 2. Presentation of Melchett Medal and Melchett Lecture, "A Century of Fuel Economy," by Professor W. A. Bone, F.R.S. 6.30 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. 2. "Life Saving Appliances on Merchant Ships" (Lecture III.), by Captain A. O. Barrand and Mr. G. A. Green. 8 p.m.

SOCIETY OF CHEMICAL INDUSTRY: LONDON SECTION.—In the Chemical Society's Rooms, Burlington House, W. 1. "Modern Trade Tendencies and where they are Leading," by Mr. H. A. F. Lindsay. 8 p.m.

SOCIETY OF ENGINEERS.—In the Apartments of the Geological Society, Burlington House, W. 1. Presidential Address by Mr. F. W. Mackenzie Skues. Presentation of Premiums awarded in 1931. 6 p.m.

WOLVERHAMPTON AND DISTRICT ENGINEERING SOCIETY.—The Victoria Hotel, Wolverhampton. "Waste Heat Boilers," by Mr. F. Jones. 7.30 p.m.

TUESDAY, FEBRUARY 2ND.

INSTITUTION OF AUTOMOBILE ENGINEERS.—At the Royal Society of Arts, John-street, Adelphi, W.C. 2. "Epicyclic Gearing," by Major W. G. Wilson. 7.45 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. "Physical Metallurgy," by Mr. C. A. Edwards. 5.15 p.m.

WEDNESDAY, FEBRUARY 3RD.

INSTITUTION OF ELECTRICAL ENGINEERS: WIRELESS SECTION MEETING.—Savoy-place, Victoria Embankment, London, W.C. 2. "The Spreading of Electromagnetic Waves from a Hertzian Dipole," by Messrs. J. A. Ratcliffe, L. G. Vedy and A. F. Wilkins. 6 p.m.

MANCHESTER METALLURGICAL SOCIETY.—In the Engineers' Club, Albert-square, Manchester. "Metals for Use at High Temperatures," by Mr. J. H. G. Monypenny. 7 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. 2. "Geophysical Methods of Prospecting," by Mr. A. Broughton Edge. 8 p.m.

THURSDAY, FEBRUARY 4TH.

INSTITUTE OF FUEL.—Joint meeting with the Society of Chemical Industry, in the Chemical Department of the University, Bristol. "Smoke Abatement," by Mr. V. R. Chadwick. 7.30 p.m.

INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—In the Chamber of Commerce, New-street, Birmingham. "The Dilatometer in the Study of Steels," by Mr. N. P. Allen. 7 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—At the Connaught Rooms, Great Queen-street, W.C. 2. Annual dinner and reunion. 7 p.m. for 7.30 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C. 2. Joint Meeting with the Institution of Mechanical Engineers, Glasgow and West of Scotland Branch. Thomas Lowe Gray Lecture, entitled "Modern Types of Propelling Machinery for Mercantile Marine Use," by Mr. Sterry B. Freeman. 7.30 p.m.

ROYAL AERONAUTICAL SOCIETY.—In the Lecture Hall of the Royal Society of Arts, John-street, Adelphi, W.C. 2. "The Organisation of Air Routes for Night Flying," by Dr. Rudolf Benkendorff. 6.30 p.m.

FRIDAY, FEBRUARY 5TH.

FARADAY HOUSE OLD STUDENTS' ASSOCIATION.—Hotel Russell, Russell-square, W.C. 1. Supper dance. 8 p.m. to 2 a.m. Tickets may be obtained from Hon. Secretary, Faraday House O.S.A., Southampton-row, W.C. 1.

INSTITUTE OF FUEL.—In the Lecture Theatre, Derby Technical College, Green-lane, Derby. "Industrial Furnace Design," by Mr. E. W. Plumley. 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W. 1. Informal Meeting. Discussion on "Pile-driving Plant," to be opened by Mr. C. H. Woodfield. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Informal meeting. Lecture, "Notes on Hydraulic Installations in New Zealand," by Mr. H. S. Lamburd. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Discourse, "Weather Forecasting," by Mr. G. C. Simpson. 9 p.m.

UNIVERSITY OF LONDON: UNIVERSITY COLLEGE ENGINEERING SOCIETY.—At University College, London, W.C. 1. Public Lecture, "High-pressure Locomotives," by Mr. H. N. Gresley. 5.30 p.m.

SATURDAY, FEBRUARY 6TH.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—Grand Hotel, Manchester. Annual dinner. 6.30 p.m.

STAFFORDSHIRE IRON AND STEEL INSTITUTE.—Dudley Arms Hotel, Dudley. Annual Dinner. 6 for 6.30 p.m.

MONDAY, FEBRUARY 8TH.

INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—In the Rooms of the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. "Aluminium-silicon Alloys: Their Properties and Some Applications," by Mr. R. B. Deeley. 7.30 p.m.

TUESDAY, FEBRUARY 9TH.

INSTITUTE OF METALS: NORTH-EAST COAST LOCAL SECTION.—Joint meeting with the Newcastle Branch, Institute of British Foundrymen, in the Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne. "Some Developments in Non-ferrous Alloy Founding," by Mr. H. C. Dews. 7.30 p.m.

INSTITUTE OF METALS: SWANSEA LOCAL SECTION.—At the Y.M.C.A., Swansea. "Zinc—the Utility Metal," by Mr. E. Evans. 6.15 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—King's Head Hotel, Coventry. "Epicyclic Gearing," by Major W. G. Wilson. 7.30 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C. 2. Joint Meeting with the Institution of Electrical Engineers, Scottish Centre. "Modern Methods of Electric Lamp Manufacture," by Mr. L. E. Buckell. 7.30 p.m.

WEDNESDAY, FEBRUARY 10TH.

INSTITUTE OF FUEL.—Joint meeting with the Sheffield Chamber of Commerce, at the Cutlers' Hall, Sheffield. "The Utilisation of Coke Oven Gas in the Iron and Steel Industry," by Dr.-Ing. H. Lent, of the Vereingte Stahlwerke A.G. 6.15 p.m.

INSTITUTE OF METALS: LONDON LOCAL SECTION.—Joint meeting with the Electroplaters and Depositors' Technical Society, at the Northampton Polytechnic Institute, St. John's-street. "Some Recent Advances in Protective Contings on Metals," by Mr. H. Sutton. 8.15 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: SOUTH MIDLAND STUDENTS' SECTION.—Joint Meeting with the Rugby Engineering Society. Alternative afternoon visits to G.P.O. Wireless Station, Hillmorton, or the British Thomson-Houston Company's Rugby Works. 3 p.m. White Heather Café, Rugby. "Recent Developments in Porcelain Insulators," by Mr. G. H. Halton. 7 p.m.

STEPHENSON LOCOMOTIVE SOCIETY.—Headquarters, King's Cross, N. 1. "Light Railways," by Mr. D. S. Barrie. 6.30 p.m.

FRIDAY, FEBRUARY 12TH.

CHEMICAL ENGINEERING GROUP.—In the Rooms of the Chemical Society, Burlington House, Piccadilly, W. 1. "A New Method for Measuring the Mechanical Properties of Metals," by Mr. L. H. Hounsfield. 8 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS: MANCHESTER CENTRE.—In the Building of the Manchester Literary and Philosophical Society, 36, George-street, Manchester, "Mechanical Breakdown," by Mr. L. W. Schuster. 7 p.m.

INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—In the Non-ferrous Section of the Applied Science Department of the University, St. George's-square, Sheffield. "Spectrographic Methods of Chemical Analysis," by Dr. H. W. Brownsdon and Mr. E. H. S. van Someren. 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "Epicyclic Transmissions," by Major W. G. Wilson. 7.30 p.m.

MONDAY, FEBRUARY 15TH.

WOLVERHAMPTON AND DISTRICT ENGINEERING SOCIETY.—The Victoria Hotel, Wolverhampton. "Beet Sugar Manufacture," by Dipl. Ing. Karl Hampel. 7.30 p.m.

TUESDAY, FEBRUARY 16TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Engineering Club, Queen-street, Wolverhampton. "The Possibilities of the Unorthodox," by Mr. Maurice Platt. 7.30 p.m.

WEDNESDAY, FEBRUARY 17TH.

INSTITUTE OF FUEL.—(This meeting has been postponed from February 10th.) Chemical Society's Rooms, Burlington House, Piccadilly, London, W. 1. "The Properties of Coals as Controlled by their Composition," by Professor George Hickling. 6 p.m.

FRIDAY, FEBRUARY 19TH.

INSTITUTION OF CHEMICAL ENGINEERS.—Hotel Victoria, Northumberland-avenue, London, W.C. 2. Annual Corporate Meeting; Presentation of Medals, 11 a.m.; Presidential Address, "Control of Industry," by Mr. W. A. S. Calder, 12 noon; "Thermal Insulation," by Dr. Ezer Griffiths, F.R.S., 2.15 p.m.; Annual Dinner, 7 for 7.30 p.m.

INSTITUTE OF FUEL.—At the Engineers' Club, 17, Albert-square, Manchester. "The Maintenance of Uniformity in Industrial Fuels," by Dr. A. C. Dunningham. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "The Ventilation and Cooling of Turbo-alternators," by Mr. D. MacFarlane. 7.30 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS.—Midland Hotel, Manchester. Annual dinner. 6.45 p.m. for 7.15 p.m.

MONDAY TO SATURDAY, FEBRUARY 22ND TO MARCH 5TH.

BRITISH INDUSTRIES FAIR, 1932.—Castle Bromwich, Birmingham, to March 4th, 1932; Olympia, London, to March 3rd, 1932; White City, to March 5th, 1932.

WEDNESDAY, FEBRUARY 24TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Engineers' Club, Albert-square, Manchester. "The Possibilities of the Unorthodox," by Mr. Maurice Platt. 7 p.m.

MONDAY, FEBRUARY 29TH.

INSTITUTE OF METALS.—Official visit to British Industries Fair, Castle Bromwich, Birmingham.

TUESDAY, MARCH 1ST.

CHEMICAL ENGINEERING GROUP.—Caxton Hall, Westminster, S.W. 1. "Some Problems Connected with High-speed Compression-ignition Engine Developments," by Mr. C. B. Dicksee. Joint General Meeting with ten other societies. 7.45 p.m.

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